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COMPARISON OF WOOD PRESERVATIVES IN STAKE TESTS (1977 PROGRESS --ETC(U)

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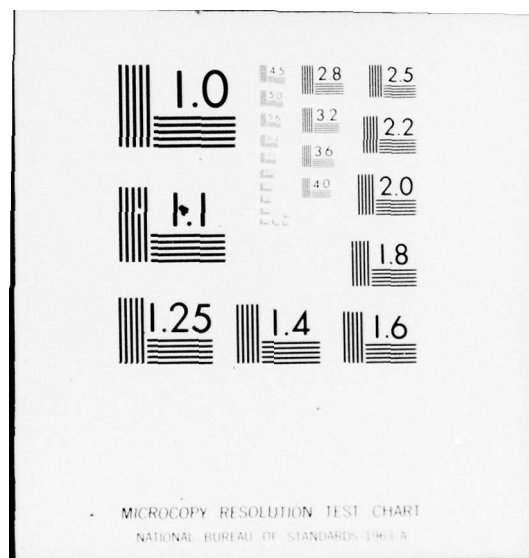
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(1977 PROGRESS REPORT)

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H. L. Davidson

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ABSTRACT

Reports results on test stakes of southern pine sapwood 2 by 4 by 18 inches in size, treated by pressure and nonpressure processes and installed by the Forest Products Laboratory and cooperators in decay and termite exposure sites at various times since 1938 at Saucier, Miss., Madison, Wis., Bogalusa, La., Lake Charles, La., Jacksonville, Fla., and the Canal Zone, Panama. Also included in the tests at Saucier, Miss., are smaller pine stakes and those of treated and untreated plywood, modified woods, laminated paper plastic, and pine infected with *Trichoderma* mold.

Southern pine untreated control stakes have had an average life of about 1 year in the Canal Zone, 1.8 to 3.6 years in Mississippi, Florida, and Louisiana, and about 6 years in Wisconsin. Superficial treatments by 3-minute dipping and brushing with preservatives such as coal-tar creosote and petroleum oils containing copper naphthenate, zinc naphthenate, phenyl mercury oleate, and pentachlorophenol have added a few months to 4 years to the life of the untreated stakes. Some waterborne preservatives have provided less protection to the stakes than the standard preservative oils, such as coal-tar creosote and pentachlorophenol solutions, when preservative retentions have corresponded to those in commercial use. Other waterborne preservatives have shown excellent results in the exposure tests.

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COMPARISON OF WOOD PRESERVATIVES IN STAKE TESTS¹ (1977 PROGRESS REPORT)

By

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U.S. Department of Agriculture

INTRODUCTION

The results of an international termite exposure test³ have indicated that pine sapwood stakes 2 by 4 by 18 inches furnish an effective means for testing the protection provided against decay and termite attack by various wood preservatives. The Forest Products Laboratory during late 1938, in cooperation with others, treated test stakes of southern pine sapwood with several preservatives for installation at the Harrison Experimental Forest at Saucier, Miss. Replicate sets were treated for installations at Madison, Wis., Bogalusa, La., Jacksonville, Fla., and the Canal Zone, Panama. Since 1938, additional preservatives have been added to these tests, principally at the Saucier, Miss., station. Also installed at that station, so their decay and termite resistance could be studied, were stakes of treated and untreated modified-wood products, such as plywood, impreg, compreg, staypak, papreg, laminated acetylated wood, cyanoethylated wood, that with thiamine destroyed, wood infected with *Trichoderma* mold, embedded fiberboard (western hemlock strands in portland cement), and particleboard.

In 1967 an installation including 11 standard wood preservatives was made in cooperation with the Wood Products Insect Laboratory, Gulfport, Miss., at Lake Charles, La., in an area infested by the destructive Formosan termite (*Coptotermes formosanus*), and for comparison at the Harrison Experimental Forest.

¹ This note is a continuation of progress reports by the same title issued periodically from 1950 to 1962 as Forest Products Laboratory Report No. 1761 and as USDA Forest Service Research Note FPL-02 since 1963.

² Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

³ Hunt, G. M., and Snyder, T. E. An International Termite Exposure Test. *Proceedings of the American Wood-Preservers' Association*, 1930, pp. 318-334. Annual progress reports published in these Proceedings each year from 1930 to 1949, again in 1952, 1956, and 1957 (final report).

Stake tests are useful for screening out ineffective materials. They can be used to advantage as a means of further exploring the preservative properties of materials that show promise in laboratory toxicity tests. The limitations of these somewhat accelerated field tests must be recognized, however, by those who wish to make use of them. They should not be considered as a substitute for actual service tests on full-size products such as ties, poles, or posts. Furthermore, the results obtained in stake tests are applicable only under the set of conditions existing in the particular test. Factors such as exposure conditions, preservative retentions, preservative distribution, heartwood volume, and size (surface area in relation to total volume) all tend to influence the performance of treated wood. With small stakes, these factors are much different from those when treated products are used under actual service conditions.

This publication is a progress report on the condition of the modified wood products and stakes, treated with the various preservatives and oils, at the time of the 1976 inspections. The tests at Panama were completed with the final inspection in January 1956. Those at Jacksonville were terminated in December 1960 and those at Bogalusa in December 1962. Progress reports showing the condition of the test stakes in 1947, and during each of the years 1949 to 1969, 1971, 1973, and 1975 were prepared previously.^{1,4}

PRESERVATIVES AND MODIFIED-WOOD PRODUCTS TESTED

Table 1 lists preservatives and other products tested, and refers to existing specifications in cases in which specifications had been issued. Table 1 also refers to tables 2 through 53 in this report, in which test data on the various materials appear. Formulations of treating solutions and descriptions of the various test materials are generally given in these tables. More complete information as to the source and composition of the various materials can, in most cases, be furnished upon request to the Forest Products Laboratory.

SELECTION AND TREATMENT OF STAKES

The stakes of modified wood, with one or two exceptions, were 4 by 18 inches with variable thicknesses. The wood stakes were, for the most part, 2- by 4-inch (nominal) by 18-inch southern pine, uniformly seasoned, surfaced four sides, and selected, as far as possible, for freedom from heartwood, wane, objectionable knots, and other visible defects. Five installations included stakes of smaller size for comparison (tables 6, 35, 37, 42, and 45). The stakes, before treatment, were identified by a number, either stamped on the ends or marked with lumber crayon.

⁴ Blew, J. O. *Comparison of Wood Preservatives in Stake Tests. Proceedings of the American Wood-Preservers' Association, 1948, pp. 88-119.*

All preservative treatments were by pressure impregnation unless otherwise indicated in the tables. Waterborne preservatives, unless otherwise noted in the tables, were applied by the full-cell process, while preservative oils were applied by either empty-cell or full-cell methods, depending upon the retentions required. Complete penetration is desirable and is usually noted in the pressure treatment used. For this reason heartwood material was avoided in the southern pine stakes unless specially noted (table 5). With few exceptions, preservative retentions were computed for individual stakes⁵ from the difference in weight before and after treatment. Surplus preservative was permitted to drain from the stakes before the final weights were taken. After past experience or exploratory treatments had indicated the correct treating schedule or the treating-solution concentration necessary to produce a desired preservative retention, twenty 2-by 4-inch stakes were treated for each test variable, from which 10 acceptable stakes were selected for installation. By discarding those stakes with retentions higher or lower than that desired, the 10 stakes selected by this procedure were usually found to have preservative retentions within 10 percent (plus or minus) of that sought. The stakes not acceptable for the test provided material for checking preservative penetrations. For stakes treated in liquefied petroleum gas (tables 42 and 45) it was impracticable to follow this general procedure. The stakes installed were treated at a commercial plant during the presence of a Laboratory representative and retentions were determined from the analysis of either sections of test stakes or from extra matched stakes included for that purpose.

The test stakes were usually identified by a numbered metal tag nailed (riveted in the case of hard or thin modified-wood products) to the wide face approximately 2 inches from the top of the stake.

INSTALLATION AND INSPECTION OF STAKES

The stakes at Madison, Wis., and Saucier, Miss., were installed in plots by the randomized-block method.⁶ The stakes were set in the ground in an upright position with about half of their length (9 in.) in the ground. The soil in the plot at the Harrison Experimental Forest, Saucier, Miss., is Norfolk fine sandy loam with a pH of 4.85. That area was cleared of trees, mostly scrub oak and gallberry with a few longleaf and slash pine, before the stakes were installed, and the ground cover is now mostly wire grass. The Madison, Wis., plot, until late 1956, was located in an area of clay loam soil partially shaded by various hardwood trees and sumac. In October 1956, it was necessary to move the stakes to a new test plot near Madison with similar soil but without overstory of trees or shrubs. The soil at Bogalusa, La., is sandy loam, and that at Jacksonville, Fla., is sandy. Both plots are partially shaded. The plot at Lake Charles, La., is located on an open area partially covered

⁵ Preservative retentions on individual stakes have not been included in this report because of the large amount of space that would be required.

⁶ Fisher, R. A., and Yates, F. *Statistical Tables for Agricultural and Medical Research*. London. 99 pp. 1938.

with broom sedge and marsh grass. The top 10 inches of soil is sandy with some streaks of clay, below which is a heavy muck and the water table.

The 1970 and 1974 inspection at Lake Charles, La., and the final inspection of stakes installed at the Canal Zone during January 1956 were made by representatives of the Wood Products Insect Laboratory, Gulfport, Miss., and the Forest Products Laboratory. The final inspections of the stakes at Jacksonville and Bogalusa were made in 1960 and 1962, respectively, by representatives of the Chapman Chemical Co. and the Forest Products Laboratory. The Madison and Saucier installations were inspected by the Forest Products Laboratory.

In these inspections, the stakes were removed individually, scraped off to facilitate inspection, examined, and then returned to their original place unless their condition indicated removal. Following the examination, the stakes were given a numerical and a letter rating according to decay and termite attack, as follows:

Decay	Termite attack
1, no decay	A, no attack
2, slightly soft or suspicious	B, nibbles or trials
3, partial or limited decay	C, limited attack (penetration)
4, bad decay	D, heavy attack
5, removed because of decay ⁷	E, removed because of termite attack ⁷

In tables 2 through 53, stakes listed as "Good" had an inspection rating of one of the following: 1A, 1B, 2A, or 2B. Stakes listed as "Serviceable but showing some decay" had one of the following inspection ratings: 3A, 3B, 4A, or 4B. Those listed as "Serviceable but showing some termite attack" were so classified on the basis of a field rating of: 1C, 2C, 1D, or 2D. Stakes listed as "Serviceable but showing some decay and termite attack" were given one of the following ratings: 3C, 3D, 4C, or 4D. Under the foregoing system of classification, stakes showing limited and heavy decay, termite attack, or both are grouped together. Undue emphasis is often placed upon this classification, in which the stakes show some deterioration but are not necessarily in serious condition. In making comparisons between preservatives, therefore, only the stakes actually destroyed should be considered.

For stakes classified as "Destroyed by decay fungi and termites," both forms of deterioration must be rated at least with bad decay or heavy attack ("4" or "D") in the inspection. In other words, a stake rated in the inspection as 3E would be considered as destroyed by termites rather than by decay and termites, while one rated as 5C would be considered

⁷ 50 pct or more of cross section destroyed.

as destroyed by decay fungi. The system used in the tables for classifying the destroyed stakes therefore emphasizes the major factor or factors responsible for damage, but it ignores those that may have been noted but that have not seriously contributed to the destruction. In estimating service life prior to 100 percent removal of stakes it has been noted that the average life is approximately at the time when 60 percent of the stakes in a group have been removed.

The foregoing system of classification is considered well suited to the requirements of tests rated on the basis of visual examination. Such methods of examination do not appear to warrant the use of elaborate or precise methods of rating or classification.

Tables 2 through 53 show the condition of the test stakes at the most recent inspection. Table 54 is a summary of results obtained in Mississippi on 2- by 4-inch pine stakes treated with wood preservatives that are in general use.

SUMMARY OF RESULTS

The results of the tests thus far can be summarized as follows:

Southern Pine and Plywood Stakes

Untreated stakes.--The untreated 2- by 4-inch southern pine sapwood stakes have had an average life of approximately 1 year in the Canal Zone, Panama, 1.8 to 3.6 years at Saucier, Miss., Bogalusa, La., and Jacksonville, Fla., and 4 to 6 years at Madison, Wis. At Lake Charles, La., 60 percent of the untreated control stakes were destroyed by Formosan termites during the first year. Untreated 3/4-inch pine sapwood stakes in Mississippi have had an average life of 1.4 to 2.1 years.

The untreated Douglas-fir plywood stakes installed at Saucier, Miss., have had an average life of about 1 to 4 years. Those glued with phenolic and urea-resin glues have lasted somewhat longer than those glued with casein glue, which have had an average life of 1 year. The stakes cut from Douglas-fir lumber and of thickness similar to that of the plywood have had an average life of slightly more than 2 years. Untreated plywood stakes of yellow birch, sweetgum, and tangile have had an average life of less than 2 years.

Pressure-treated stakes.--In the newer installations and in those with the more effective preservatives only a limited number of stakes has thus far been removed, and the average life of stakes pressure-treated with various preservatives cannot yet be determined. Estimates on average life were made for preservatives with significant failures at the time of the termination of several installations (see tables 2, 3, 4, 5, 8, 12, 18, and 38). In the Canal Zone, stakes treated with several retentions of chromated zinc arsenate have been destroyed during the 15-1/3 years

of exposure. Stakes with 0.33 (0.22 oxide basis) pound per cubic foot of the preservative had an average life of 9 years, while those with approximately 1.05 (0.69 oxide basis) pounds had an average life of 15.3 years. With chromated zinc arsenate retentions of 0.33 (0.22 oxide basis) pound to 1.06 (0.70 oxide basis) pounds per cubic foot, failures have occurred in Wisconsin, while after 36 years in Mississippi failures have been noted only with the low retention (table 4; see similar comparison in table 20). This is attributed to the presence of arsenic-tolerant fungi at the Wisconsin test area.

Stakes treated with retentions of from 0.5 (0.30 oxide basis) to 1.0 (0.61 oxide basis) pound of chromated zinc chloride per cubic foot lasted, on an average, about 5 to 7 years in Panama, 14 to 20 years in Mississippi, and 15 to 18 years in Wisconsin. In Panama, stakes treated with fluor chrome arsenate phenol with average retentions of 0.2 (0.16 oxide basis) to 0.3 (0.24 oxide basis) pound per cubic foot had an average life of about 3 and 6 years, respectively. With stakes treated with 0.6 (0.48 oxide basis) pound per cubic foot, the average life in Panama was 14 years. In Mississippi, stakes treated with 0.2 (0.16 oxide basis), 0.3 (0.24 oxide basis), and 0.6 (0.48 oxide basis) pound of fluor chrome arsenate phenol per cubic foot had an average life of about 10, 18, and 24 years, respectively. Stakes in Wisconsin treated with similar retentions of that preservative had an average life of 14 to 16 years.

Of the waterborne preservatives in test (25 to 31 yrs or longer in Mississippi), the formulations containing either copper and arsenic (ammoniacal copper arsenate, table 14) or copper, chromium, and arsenic (chromated copper arsenate, tables 15 and 20) are the better performers with no failures with retentions of 0.5 (0.29 oxide basis) per cubic foot or higher.

Results thus far on installations of pentachlorophenol with similar retentions (approximately 0.2 lb/ft³) and with different hydrocarbon solvents (tables 17, 42, and 45), show better performance with solutions containing the heavy solvents such as heavy gas oil, lube oil extract (table 17), No. 4 aromatic oil (table 22), and AWP A P9 (heavy petroleum solvent) (tables 42 and 45), than with volatile (LPG) or light oils such as Stoddard solvent (mineral spirits) (tables 17 and 42). Preservatives such as rosin amine-D-pentachlorophenate (tables 22 and 23), tributyltin oxide (tables 36 and 41), and copper-8-quinolinolate (tables 38 and 43) also show better performance with the heavy petroleum solvent than with the light Stoddard solvent (mineral spirits). The above-mentioned heavy petroleum solvents have the following properties:

Petroleum oils	API	Flash	Vis-	Penta	Distillation		
	gravity	point	cosity	solveny	IBP	50	EP
	60° F	(PMCC)	SUS at	at		percent	
		(°F)	100° F	75° F	(°F)	(°F)	(°F)
				(Pct)			
Heavy gas oil,							
No. 101	8.3	345	167.4	20-22	600	700	734
Lube oil extract	5.1	295	196.4	28-30	440	696	736
AWPA P9 (heavy)	23.8	225	38.4	15	480	538	647
No. 4 aromatic	6.8	230	72.6	10+	458	592	Cracked, (85 pct)

Coal-tar creosotes installed in Mississippi during 1940 and 1941 (tables 4, 5, and 6) have shown better performance than those installed in 1948 (tables 18 and 19). In the latter installation, 10 coal-tar creosotes with a retention of approximately 8 pounds per cubic foot showed only a few serviceable stakes after 20 years and the average life was determined or estimated at 14 to 21 years. Creosotes installed earlier showed only 20 to 60 percent failures in 35 to 36-1/2 years.

Stakes pressure treated with the fire-retarding formulation containing ammonium phosphate and ammonium sulfate lasted, on an average, only 2 to 3 years in Mississippi. With these ammonium salts plus borax and boric acid, the stakes installed in 1943 lasted on the average of about 4 years. The fire-retarding formulation with borax and boric acid alone has provided protection against decay and termites for an average of about 6 years. The addition of zinc chloride and chromium compounds to combinations of boron and ammonium salts in fire retardants improves protection against decay fungi and termites.

Douglas-fir plywood stakes treated with 6 and 12 pounds per cubic foot of coal-tar creosote have performed somewhat better in Mississippi than those treated with 26 pounds of 1.1 percent or 2.25 percent pentachlorophenol in light solvent per cubic foot (Table 8).

The results of stake tests in Mississippi show copper naphthenate is furnishing greater protection than zinc naphthenate with similar retentions.

Stakes pressure treated with various concentrations of phenyl mercury oleate in naphtha have lasted from 5 to 9 years in Mississippi. This chemical alone did not perform quite so well as did a proprietary product containing a water repellent.

Rosin amine D pentachlorophenate in Stoddard solvent is performing less satisfactorily than is pentachlorophenol with that solvent and similar retentions. Naval stores products such as rosin oil, oleo resin, and drop liquor concentrate with petroleum solvents appear to have limited value as preservatives but are improved by the addition of pentachlorophenol. Urea (table 10) has also shown limited protection. Stakes pressure treated with 5.8 pounds per cubic foot had an average life of 9.1 years in

Mississippi. Other products showing limited preservative value in the retentions used are acrylonitrile (cyanoethylation), ammonium hydroxide (thiamine destruction), amyl phenyl acetate, capric acid, copper-8-quinolinolate (in Stoddard solvent), diamyl phenol, DDT, dodecyl amine, nickel stearate, and tributyltin oxide (in Stoddard solvent).

An indication of the influence of size of test stakes can be noted in table 6 where, with a coal-tar creosote retention of 8 pounds per cubic foot, 1/2-inch square stakes show an average life of 17 years with 100 percent removed in 21-1/2 years. After 33-1/2 years, 1-1/2-inch square stakes show 100 percent failures with an average life of 26.6 years, while 2- by 4-inch stakes show 30 percent failures. Also of interest in table 6 is the performance of 2 by 4 stakes treated with 3.3 pounds of coal-tar creosote per cubic foot which show an average life of 24.9 years. With a similar retention of creosote, but with the preservative applied in dilution (11.25 pct) with toluene, the stakes show an average life of 19.1 years.

Nonpressure-treated stakes.--Southern pine stakes and Douglas-fir plywood stakes treated by superficial applications, such as brushing and brief dipping in coal-tar creosote and solutions of pentachlorophenol, copper naphthenate, zinc naphthenate, and phenyl mercury oleate, have, in general, lasted 1 to 4 years longer than the untreated control stakes. Stakes dipped for 15 minutes in coal-tar creosote had a life of about 8 years in Mississippi, however. For the plywood stakes in which the veneer was treated by dipping or long soaking in the preservatives before gluing, the results have generally been more favorable than for plywood similarly treated after gluing. Stakes soaked 18 hours in solutions of pentachlorophenol or mixtures of chlorinated phenols have lasted 5 to 10 years in the Canal Zone. In the United States, the stakes soaked 18 hours in these solutions lasted 8 to 16 years. Douglas-fir plywood stakes treated by brushing, dipping, and 18-hour soaking in chloro-2-phenylphenol solution, however, have lasted only a few months longer than the untreated plywood control stakes. Douglas-fir plywood stakes treated by soaking 18 hours in pentachlorophenol solution had a life of 5 years, while those similarly treated with coal-tar creosote have an estimated average of 24 years.

Pine stakes treated by soaking in urea solution have lasted about 1 to 1-1/2 years longer than the control stakes in Mississippi, while those similarly treated with ureaformaldehyde solution have lasted about 3 to 4 years longer than the controls.

Pine stakes with higher retentions of copper chromate and with copper arsenate applied by double-diffusion have continued to perform well after 35 years in Mississippi. Failures thus far, however, are attributed to poor penetration of the preservative.

Modified-Wood Stakes

Plywood impregnated with phenolic resin (impreg) and impregnated and compressed (compreg) has been considerably more resistant to decay and termite attack than untreated plywood of the same species. Plywood stakes with a low resin content had an average life of approximately 7 years and those with a high resin content lasted 12 years. In Douglas-fir plywood stakes with phenolic-resin-impregnated faces and untreated cores, an average life of about 3.5 years has been obtained, and somewhat better results have been noted when the edges of the plywood have been protected with a phenolic-resin coating. Southern pine 2- by 4-inch stakes impregnated with a low resin content had an average life of 12 years while those with a higher content of phenolic resin have lasted somewhat longer.

Laminated paper plastic made with phenolic resin has shown limited resistance to decay and termite attack, with the life of the stakes averaging about 6 to 8 years. Heat-stabilized birch and maple plywood (staypak) stakes have lasted about 4 to 6 years. The staypak with veneer of 1/16-inch thickness has performed better than that with 1/8-inch veneer, presumably since the thinner veneer permits a better distribution of the phenolic-resin adhesive in the plywood.

Acetylated birch (laminated veneer) has had reasonably good resistance to decay and termite attack with an average life of 17.5 years in Mississippi. Deterioration is due principally to decay fungi.

Untreated stakes of aspen particleboard installed in 1973 are now destroyed with an average life of 2.5 years. It is interesting to note that this material treated with chromated copper arsenate and fluor chrome arsenate phenol is showing less degradation than that treated with pentachlorophenol (Table 49).

The nontoxic preservatives propylene oxide, butylene oxide, and epichlorohydrin in combination with propylene oxide are all showing various degrees of degradation by termites and decay after 2 years service (Table 50).

NOTE

CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife--if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.

Mention of a chemical in this report does not constitute a recommendation; only those chemicals registered by the U.S. Environmental Protection Agency may be recommended, and then only for uses as prescribed in the registration--and in the manner and at the concentration prescribed. The list of registered chemicals varies from time to time; prospective users, therefore, should get current information on registration status from Environmental Protection Agency, Washington, D.C.

Crankcase oils may contain chlorinated naphthalenes, which have been reported to contribute to "X-disease" (hyperkeratosis) in cattle. These oils are therefore not recommended for preservative treatment of wood with which cattle may come in contact.

Table 1.--Index to materials tested

Materials	Existing specification or AWP reference	Table No.
<u>Chemicals</u>		
Acid copper chromate	: Fed. Spec. TT-W-546; AWP P5	: 15, 16, 46, 47
Acrylonitrile	: --	: 36
Aldrin	: --	: 41
Ammoniacal copper arsenate	: Fed. Spec. TT-W-549; AWP P5	: 14, 47, 51, 52
Ammoniacal copper borate	: --	: 52
Ammonium hydroxide	: --	: 36
Ammonium sulfate-phosphate	: Navy Spec. 51C38	: 13
Amyl phenyl acetate	: --	: 14
Basic zinc chloride	: --	: 26
Basilit UA	: --	: 30
Boliden salt S-25	: --	: 24
Borax-boric acid	: Navy Spec. 51C38	: 13
Butylene oxide	: U.S. Patent No. 3,985,721	: 50
Capric acid	: --	: 14
Chloro-2-phenylphenol	: --	: 5, 8
Chromated copper arsenate	: AWP P5, Type A; Fed. Spec. : TT-W-550 Type I	: 15, 47
Chromated copper arsenate	: AWP P5, Type B; Fed. Spec. : TT-W-550 Type II	: 20, 47
Chromated copper arsenate	: Fed. Spec. TT-W-550 Type III	: 48, 49, 51
Chromated zinc arsenate	: Formerly in Fed. Spec. TT-W-538; : AWP P5	: 4, 24
Chromated zinc chloride	: Fed. Spec. TT-W-551; AWP P5	: 2, 16, 25, 35, 47
Chromated zinc chloride, copperized	: Formerly in Fed. Spec. TT-W-562; : AWP P5	: 31
Chromated zinc chloride (FR)	: AWP P10, Type B	: 25
Copper arsenate	: AWP Proc. 1941; pp. 23-31	: 9
Copper chromate	: AWP Proc. 1941; pp. 23-31	: 9
Copper-chrome boron (CB)	: U.S. Patent No. 3,007,844	: 46
Copper-chrome-phosphorus	: --	: 48
Copper formate	: --	: 34
Copper naphthenate	: AWP P8	: 7, 12, 16, 17, 29
Copper-8-quinolinolate	: AWP P8	: 38, 43
Creosote, coal-tar	: AWP P1; Fed. Spec. TT-C-645	: 4, 5, 6, 8
	: --	: 16, 17, 18, 19, 20,
	: --	: 31, 35, 47
Creosote, coal-tar (English)	: --	: 18, 19
Creosote, coal-tar (low temperature)	: --	: 28
Creosote, coal-tar (Texas lignite)	: --	: 32
Creosote-coal tar solution	: AWP P2; Fed. Spec. TT-C-650	: 18, 47
Creosote-petroleum solution	: Fed. Spec. TT-W-568	: 18, 47
Creosote toluene	: --	: 6
Diamyl phenol	: --	: 14
Dichloro-diphenyl-trichloroethane (DDT)	: --	: 14
Dieldrin	: --	: 41
Dodecyl amine	: --	: 14
Drop-liquor concentrate	: --	: 27
Epichlorohydrin	: U.S. Patent No. 3,985,921	: 50

(Page 1 of 2)

Table 1.--Index to materials tested--continued

Materials	Existing specification or AWPA reference	Table No.
<hr/>		
Chemicals--continued		
Fire retardants	--	: 53
Fire retardants	:AWPA P10	: 25
Fluor chrome arsenate phenol	:AWPA P5; Fed. Spec. TT-W-535	: 2, 33, 37, 47, 49
	: Type A	:
Fluor chrome arsenate phenol	:AWPA P5; Fed. Spec. TT-W-535	: 47
	: Type B	:
Fuel oils	--	: 5, 17, 27
Heptadecyltrimethyltetra-hydropyrimidine (HTP)	--	: 44
KP (copper oxide and chlorophenol)	--	: 35
Lignite-tar extracts	--	: 39
Mercuric chloride	--	: 12
Minalith	:AWPA P10, Type C	: 25
Nickel-chromium-arsenic salt	--	: 15
Nickel-stearate	--	: 14
Oleo resin	--	: 27
Paraffin	--	: 32
Pentachlorophenol	:AWPA P8; Fed. Spec. TT-W-570	: 5, 8, 12, 16, 17, 22,
		: 23, 27, 29, 31, 32,
		: 33, 41, 42, 43, 45,
		: 47, 49
Petroleum oils (various types)	--	: 17, 18, 21, 23, 45
Phenyl mercury oleate	--	: 12
Propylene oxide	:U.S. Patent No. 3,985,921	: 50
Pyresote	:AWPA P1C, Type D	: 25
Rosin amine D copper acetate complex	--	: 27
Rosin amine D pentachlorophenolate	--	: 22, 23
Rosin oil	--	: 27
Sodium pentachlorophenolate	--	: 2, 5
Sodium tetrachlorophenolate	--	: 2
Toluene	--	: 6
Tributyltin oxide	--	: 36, 41
Urea	--	: 10
Zinc-arsenate-chromium salts	--	: 20
Zinc chloride	--	: 2, 4, 20, 26
Zinc naphthenate	--	: 7, 8
Modified woods, plywood, and paper plastic		
Acetylated wood	--	: 14
Cyanoethylated wood	--	: 36
Embedded fiberboard	--	: 40
Heat-stabilized wood (stavpak)	--	: 11
Laminated paper plastic (papreg)	--	: 11
Impreg and compreg	--	: 3
Mold-infected wood	--	: 31
Particleboard	--	: 49
Plywood	--	: 3, 8, 16, 33, 51
Wood with thiamine destroyed	--	: 36

Table 2.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.) treated with chlorinated phenols and with fluor chrome arsenate phenol--Type A, zinc chloride, and chromated zinc chloride, after 15 to 25 years of service. Stakes placed in test at Barro Colorado Island, Canal Zone, September 1918; Bogalusa, La., December 1919; Jacksonville, Fla., January 1939; Harrison Experimental Forest, Saucier, Miss., December 1939; and Madison, Wis., November 1939

Preservative	Loca- tion	Retention of salts ¹			Number in test ²	Condition of stakes late in 1963 ³						Total removed	Average life
		Minimum	Maximum	Average		Good	Serviceable but showing some--	Destroyed by--	Decay	Termite	Decay		
									fungi	and	fungi		
									attack	and	attack		
									termite	termite	termite		
									attack	attack	attack		
		Pct	Pct	Pct		Pct	Pct	Pct	Pct	Pct	Pct	Num- ber	Pct
													Yr
Sodium-penta- chlorophenate	Canal	0.24	0.28	0.26	10	--	--	--	--	--	100	10	6.9
	La.	.24	.28	.26	10	--	--	--	10	--	90	10	9.2
	Fla.	.25	.28	.26	9	--	--	--	11	--	89	9	14.2
	Miss.	.24	.28	.26	10	--	--	--	10	20	70	10	11.9
	Wis.	.24	.28	.26	10	--	--	--	100	--	--	10	12.5
	Canal	.45	.54	.50	10	--	--	--	--	20	80	10	11.2
	La.	.45	.53	.49	10	--	--	--	30	--	70	10	10.7
	Fla.	.46	.55	.50	10	--	--	--	20	--	80	8	22.0
	Miss.	.44	.54	.49	10	--	--	--	10	--	90	10	19.4
	Wis.	.44	.53	.49	10	--	--	--	100	--	--	10	16.4
	Canal	.69	.81	.75	10	--	--	--	10	20	70	10	11.7
	La.	.69	.85	.75	10	--	--	--	10	--	90	10	15.6
	Fla.	.68	.82	.74	10	--	--	--	40	10	50	6	22.0
	Miss.	.69	.84	.76	10	--	--	--	40	--	60	10	21.6
	Wis.	.67	.81	.76	10	--	--	--	100	--	--	10	21.0
	Canal	.92	1.06	.98	10	--	--	--	--	10	90	10	14.3
	La.	.93	1.09	.99	10	--	--	--	10	--	90	10	16.2
	Fla.	.92	1.08	.98	20	--	--	--	60	10	30	4	--
	Miss.	.93	1.09	.97	10	--	--	--	20	--	80	10	25.0
	Wis.	.86	1.01	.90	10	--	--	--	100	--	--	10	23.4
Sodium tetra- chlorophenate	Canal	.24	.27	.25	10	--	--	--	--	60	40	10	4.8
	La.	.23	.27	.25	10	--	--	--	20	--	80	10	8.1
	Fla.	.23	.28	.25	9	--	--	--	22	--	78	9	11.3
	Miss.	.23	.27	.25	10	--	--	--	10	--	90	10	10.7
	Wis.	.24	.27	.25	10	--	--	--	100	--	--	10	11.4
	Canal	.47	.56	.51	10	--	--	--	--	20	80	10	9.9
	La.	.46	.55	.50	10	--	--	--	--	30	70	10	10.9
	Fla.	.47	.55	.51	10	--	--	--	--	--	100	10	15.3
	Miss.	.48	.58	.52	10	--	--	--	--	--	100	10	15.1
	Wis.	.47	.55	.50	10	--	--	--	100	--	--	10	14.5
	Canal	.70	.83	.76	10	--	--	--	--	--	100	10	13.1
	La.	.71	.83	.77	10	--	--	--	--	30	70	10	11.9
	Fla.	.68	.83	.76	9	--	--	--	--	11	89	9	16.7
	Miss.	.68	.82	.75	10	--	--	--	--	--	100	10	19.7
	Wis.	.67	.81	.75	9	--	--	--	100	--	--	9	16.7
Fluor chrome arsenate phenol-- Type A	Canal	.18 (.11)	.22 (.14)	.20 (.12)	10	--	--	--	--	100	--	10	2.9
	La.	.19 (.12)	.22 (.14)	.20 (.12)	10	--	--	--	--	50	50	10	9.6
	Fla.	.18 (.11)	.21 (.13)	.20 (.12)	10	--	--	--	--	50	50	10	13.9
	Miss.	.18 (.11)	.21 (.13)	.20 (.12)	10	--	--	--	--	10	50	40	10.2
	Wis.	.13 (.08)	.22 (.14)	.20 (.12)	10	--	--	--	--	100	--	10	13.8
	Canal	.28 (.17)	.33 (.20)	.30 (.19)	10	--	--	--	--	30	70	10	6.4
	La.	.28 (.17)	.32 (.20)	.30 (.19)	10	--	--	--	--	20	80	10	13.7
	Fla.	.29 (.18)	.32 (.20)	.30 (.19)	10	--	--	--	--	100	--	10	15.4
	Miss.	.29 (.18)	.32 (.20)	.30 (.19)	10	--	--	--	--	10	90	10	18.0
	Wis.	.27 (.17)	.30 (.19)	.28 (.17)	10	--	--	--	--	100	--	10	16.5
	Canal	.53 (.33)	.66 (.41)	.60 (.37)	10	--	--	--	--	40	60	10	14.2
	La.	.56 (.35)	.64 (.40)	.60 (.37)	10	--	--	--	--	50	50	10	15.6
	Fla.	.57 (.35)	.65 (.40)	.61 (.38)	10	--	--	--	--	100	--	10	17.5
	Miss.	.57 (.35)	.65 (.40)	.61 (.38)	10	--	--	--	--	60	40	10	24.1
	Wis.	.59 (.36)	.68 (.42)	.65 (.40)	10	--	--	--	--	100	--	10	16.0
Sodium penta- chlorophenate and sodium chloride ⁵	Canal	.52	.55	.54	10	--	--	--	--	30	70	10	8.7
	La.	.46	.53	.49	10	--	--	--	--	100	10	100	13.3
	Fla.	.48	.54	.50	10	--	--	--	50	10	40	5	--
	Miss.	.46	.53	.49	10	--	--	--	--	100	10	100	16.3
	Wis.	.46	.53	.50	10	--	--	--	--	100	--	10	16.8

Table 2.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.) treated with chlorinated phenols and with fluor chrome arsenate phenol--Type A, zinc chloride, and chromated zinc chloride, after 15 to 25 years of service. Stakes placed in test at Barro Colorado Island, Canal Zone, September 1938; Bogalusa, La., December 1939; Jacksonville, Fla., January 1939; Harrison Experimental Forest, Saucler, Miss., December 1939; and Madison, Wis., November 1939--continued

Preservative	Location	Retention of salts ¹			Number: In ₂ test ²	Condition of stakes late in 1963 ³						Total removed	Average life		
		Minimum	Maximum	Average		Good	Serviceable but showing some--	Destroyed by--							
							Decay:Termite: Decay: attack: and: fungi:attack: fungi: termite: termite: termite: attack: attack: attack:								
		Pcf	Pcf	Pcf		Pct	Pct	Pct	Pct	Pct	Pct	Num- ber	Pct	Yr	
Zinc chloride	Canal:	0.44 (0.26):	0.53 (0.32):	0.47 (0.28):	10	--	--	--	--	--	30	70	10	100	3.9
	La.:	.45 (.27):	.55 (.33):	.50 (.30):	10	--	--	--	--	30	--	70	10	100	8.1
	Fla.:	.45 (.27):	.53 (.32):	.49 (.29):	10	--	--	--	--	20	--	80	10	100	12.9
	Miss.:	.45 (.27):	.54 (.32):	.50 (.30):	10	--	--	--	--	40	--	60	10	100	15.4
	Wis.:	.45 (.27):	.53 (.32):	.49 (.29):	10	--	--	--	--	100	--	--	10	100	18.2
	Canal:	.70 (.42):	.82 (.49):	.76 (.45):	10	--	--	--	--	--	--	100	10	100	3.9
	La.:	.70 (.42):	.78 (.47):	.74 (.44):	10	--	--	--	--	40	--	60	10	100	12.1
	Fla.:	.71 (.42):	.82 (.49):	.75 (.45):	10	--	--	--	--	40	--	60	10	100	13.5
	Miss.:	.70 (.42):	.79 (.47):	.74 (.44):	10	--	--	--	--	20	10	70	10	100	16.7
	Wis.:	.65 (.39):	.87 (.52):	.75 (.45):	9	--	--	--	--	100	--	--	9	100	18.9
	Canal:	.94 (.56):	1.08 (.64):	1.00 (.60):	10	--	--	--	--	--	40	60	10	100	4.0
	La.:	.94 (.56):	1.08 (.64):	1.01 (.60):	10	--	--	--	--	70	--	30	10	100	11.6
	Fla.:	.95 (.57):	1.08 (.64):	1.02 (.61):	10	--	--	--	--	20	--	80	10	100	15.4
	Miss.:	.94 (.56):	1.07 (.64):	1.00 (.60):	10	--	--	--	--	10	--	90	10	100	17.3
	Wis.:	.93 (.56):	1.13 (.68):	1.02 (.61):	10	--	--	--	--	100	--	--	10	100	19.0
Chromated zinc chloride	Canal:	1.40 (.84):	1.62 (.97):	1.49 (.89):	10	--	--	--	--	--	10	90	10	100	7.3
	La.:	1.44 (.86):	1.63 (.97):	1.52 (.91):	10	--	--	--	--	40	--	60	10	100	11.1
	Fla.:	1.41 (.84):	1.62 (.97):	1.49 (.89):	10	--	--	--	--	20	--	80	10	100	15.7
	Miss.:	1.43 (.85):	1.63 (.97):	1.52 (.91):	10	--	--	--	--	60	--	40	10	100	17.9
	Wis.:	1.36 (.81):	1.74 (1.04):	1.59 (.94):	10	--	--	--	--	100	--	--	10	100	18.7
	Canal:	.45 (.28):	.55 (.34):	.49 (.30):	10	--	--	--	--	--	--	100	10	100	4.9
	La.:	.46 (.28):	.55 (.34):	.49 (.30):	10	--	--	--	--	40	10	50	10	100	8.6
	Fla.:	.45 (.28):	.53 (.33):	.49 (.30):	8	--	--	--	--	25	--	75	8	100	14.3
	Miss.:	.45 (.28):	.55 (.34):	.49 (.30):	10	--	--	--	--	30	10	60	10	100	14.2
	Wis.:	.43 (.26):	.53 (.33):	.47 (.29):	10	--	--	--	--	100	--	--	10	100	16.9
	Canal:	.70 (.43):	.81 (.50):	.76 (.47):	10	--	--	--	--	--	--	100	10	100	7.2
	La.:	.70 (.43):	.80 (.49):	.76 (.47):	10	--	--	--	--	40	--	60	10	100	10.6
	Fla.:	.73 (.45):	.81 (.50):	.77 (.47):	9	--	--	--	--	11	--	89	9	100	14.3
	Miss.:	.72 (.44):	.81 (.50):	.76 (.47):	10	--	--	--	--	40	--	60	10	100	20.2
	Wis.:	.70 (.43):	.86 (.53):	.80 (.49):	10	--	--	--	--	100	--	--	10	100	14.7
Untreated controls	Canal:	.95 (.58):	1.11 (.68):	1.02 (.63):	10	--	--	--	--	10	--	90	10	100	6.6
	La.:	.93 (.57):	1.07 (.66):	1.00 (.62):	10	--	--	--	--	40	--	60	10	100	11.9
	Fla.:	.96 (.59):	1.09 (.67):	1.02 (.63):	10	--	--	--	--	10	20	70	9	90	17.0
	Miss.:	.96 (.59):	1.09 (.67):	1.02 (.63):	10	--	--	--	--	50	--	50	10	100	20.1
	Wis.:	.89 (.55):	1.13 (.70):	1.02 (.63):	10	--	--	--	--	100	--	--	10	100	18.2

¹Retention values in parentheses are based on preservative oxides.

²10 stakes were originally installed at each test station. This number has since been reduced either because of failure to locate the stakes at the time of the inspection or because of damage by fire.

³Final inspection at Canal Zone February 1954; at Louisiana December 1958; at Florida December 1960; at Wisconsin October 1963; and at Mississippi December 1963.

⁴Estimate based on percentage of stakes remaining after final inspection.

⁵Retention values based on sodium pentachlorophenate only. Sodium chloride added was equal to 20 pct of weight of sodium pentachlorophenate in solution.

Table 4.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.) treated with chromated zinc arsenate (Boliden salts), zinc chloride, and coal-tar creosote, after 15 to 16 1/2 years of service. Stakes placed in test at Madison, Wis., September 1940; Harrison Experimental Forest, Sandier, Miss., June 1940; and Barro Colorado Island, Canal Zone, September 1940.

Preservative	Loca- tion	Average retention		Num- ber	Condition of stakes November 1976 ¹						Total removed	Average life				
		Oil	Dry salt ²		Good	Serviceable but showing some--	Destroyed by--	Decay/termite:	decay	fungi						
				test				attack	and	termite:	termite:	attack				
								attack	and	termite:	termite:	attack				
								attack	and	termite:	termite:	attack				
		Pct	Pct		Pct	Pct	Pct	Pct	Pct	Pct	Num- ber	Pct	Yr			
Zinc chloride	Wis.	--	0.50 (0.30):	10	--	--	--	--	100	--	--	10	100	14.8		
	Miss.	--	.50 (.30):	10	--	--	--	--	60	--	40	10	100	14.2		
	Canal	--	.49 (.29):	10	4	--	--	--	--	--	100	10	100	3.0		
	Wis.	--	1.03 (.61):	10	--	--	--	--	100	--	--	10	100	19.8		
	Miss.	--	1.02 (.61):	10	--	--	--	--	60	10	30	10	100	14.4		
	Canal	--	1.01 (.60):	10	--	--	--	--	--	--	100	10	100	3.6		
	Wis.	--	1.51 (.90):	10	--	--	--	--	100	--	--	10	100	22.3		
	Miss.	--	1.51 (.90):	10	--	--	--	--	60	--	40	10	100	18.1		
	Canal	--	1.49 (.89):	10	--	--	--	--	--	--	100	10	100	4.5		
	Chromated zinc arsenate: (Boliden salts) ³	Wis.	--	.33 (.22):	10	--	--	--	--	100	--	--	10	100	19.6	
		Miss.	--	.33 (.22):	10	--	--	--	--	20	30	--	50	8	80	--
		Canal	--	.33 (.22):	10	--	--	--	--	--	--	100	10	100	9.2	
Wis.		--	.44 (.29):	10	--	--	--	--	100	--	--	10	100	26.5		
Miss.		--	.44 (.29):	9	--	--	--	--	44	12	--	44	5	56	--	
Canal		--	.44 (.29):	10	--	--	--	--	--	30	10	60	10	100	11.6	
Wis.		--	.60 (.40):	10	--	10	--	--	90	--	--	9	90	--		
Miss.		--	.58 (.38):	10	--	--	--	--	90	--	--	10	1	10	--	
Canal		--	.58 (.38):	10	--	--	--	--	60	40	--	10	100	14.6		
Wis.		--	.78 (.52):	10	--	20	--	--	80	--	--	8	80	--		
Miss.		--	.78 (.52):	10	--	--	--	--	100	--	--	--	--	--		
Canal		--	.78 (.52):	10	--	--	--	--	100	--	--	10	100	15.1		
Wis.		--	1.06 (.70):	10	--	40	--	--	60	--	--	6	60	--		
Miss.		--	1.06 (.70):	10	--	--	--	--	100	--	--	--	--	--		
Canal		--	1.05 (.69):	10	--	--	--	--	100	--	--	10	100	15.3		
Coal-tar creosote		Wis.	4.3	--	10	--	40	--	--	60	--	--	6	60	--	
		Miss.	4.2	--	10	--	--	--	--	60	--	40	10	100	17.8	
		Canal	4.3	--	10	--	--	--	--	40	--	60	10	100	13.4	
	Wis.	8.0	--	10	--	100	--	--	--	--	--	--	--	--		
	Miss.	8.0	--	10	--	--	--	--	60	30	--	10	4	40	--	
	Canal	8.0	--	10	--	60	--	--	10	30	--	3	30	2.19		
	Wis.	11.8	--	10	20	80	--	--	--	--	--	--	--	--		
	Miss.	11.8	--	10	--	--	--	--	80	10	--	10	2	20	--	
	Canal	11.8	--	10	--	60	--	--	--	40	--	4	40	2.18		
	Wis.	16.3	--	10	40	60	--	--	--	--	--	--	--	--		
	Miss.	16.5	--	10	10	--	--	--	90	--	--	--	--	--		
	Canal	16.5	--	10	--	90	--	--	10	--	--	--	--	--		
	Wis.	5.1.8	--	10	--	--	--	--	100	--	--	10	100	12.4		
	Miss.	5.1.8	--	10	--	--	--	--	10	30	60	10	100	7.7		
	Canal	5.1.8	--	10	--	--	--	--	--	80	20	10	100	4.8		
	Wis.	6.7.1	--	10	--	--	--	--	100	--	--	10	100	8.4		
	Miss.	6.7.6	--	10	--	--	--	--	--	50	50	10	100	4.2		
	Canal	6.7.6	--	10	--	--	--	--	--	90	10	10	100	2.5		
Untreated controls	Wis.	--	--	10	--	--	--	--	100	--	--	10	100	6.2		
	Miss.	--	--	10	--	--	--	--	--	50	50	10	100	2.2		
	Canal	--	--	10	--	--	--	--	--	90	10	10	100	1.1		

¹Final inspection at Canal Zone January 1956.

²Retention values in parentheses are based on preservative oxides.

³Retention based upon total anhydrous salts: $ZnSO_4 \cdot H_2O + Na_2As_2O_7 + Na_2Cr_2O_7$.

⁴Estimate based upon percentage of stakes remaining after final inspection.

⁵15-min. dry at room temperature.

⁶Brush treatment, 2 coats.

Table 5.--Condition of southern pine stakes (2 x 4 in., nominal x 18 in.), treated with chlorinated phenols and coal-tar creosote, after 15 to 16 years of service. Stakes placed in test at Barro Colorado Island, Canal Zone, February 1941; Bogalusa, La., March 1941; Jacksonville, Fla., March 1941; and Harrison Experimental Forest, Saucier, Miss., February 1941

Preservative	Location	Retention of preservative ¹			Number in test ²	Condition of stakes December 1976 ³						Total removed	Average life		
		Minimum	Maximum	Average		Good	Serviceable but showing some--	Destroyed by--							
								Decay	Termite	Decay					
											fungi			and	termite
						attack	and	termite	attack						
		Pct	Pct	Pct		Pct	Pct	Pct	Pct	Pct	Pct	Pct	Number	Pct	Yr
													ber		
Sodium pentachlorophenate	Canal	0.23	0.27	0.25	10	--	--	--	--	--	60	40	10	100	6.4
	La.	.23	.26	.25	10	--	--	--	--	10	--	90	10	100	10.0
	Fla.	.23	.26	.25	9	--	--	--	--	--	--	100	9	100	14.5
	Miss.	.23	.26	.25	10	--	--	--	--	20	--	80	10	100	16.9
	Canal	.31	.34	.33	10	--	--	--	--	--	10	90	10	100	10.9
	La.	.31	.34	.33	10	--	--	--	--	--	--	100	10	100	10.4
	Fla.	.32	.34	.33	8	--	--	--	--	--	12	88	8	100	16.3
	Miss.	.31	.34	.33	10	--	--	--	--	20	--	80	10	100	19.5
	Canal	.47	.55	.51	10	--	--	--	--	--	20	80	10	100	12.9
	La.	.48	.54	.51	10	--	--	--	--	--	--	100	10	100	15.5
	Fla.	.47	.54	.50	10	--	--	--	50	--	--	50	5	50	--
	Miss.	.47	.55	.51	10	--	--	--	--	10	--	90	10	100	21.3
	Canal	.73	.81	.77	10	--	--	--	--	50	20	30	10	100	14.3
	La.	.72	.82	.77	8	--	--	--	50	--	--	50	4	50	--
	Fla.	.72	.83	.77	10	--	--	--	80	--	--	20	2	20	--
	Miss.	.72	.83	.77	10	--	--	--	--	--	--	100	10	100	26.2
	Canal	.92	1.09	.99	10	--	--	--	--	70	--	30	10	100	14.2
	La.	.92	1.09	.99	7	--	--	--	57	--	--	43	3	43	--
	Fla.	.91	1.10	.99	9	--	--	--	100	--	--	--	--	--	--
	Miss.	.93	1.08	.99	10	--	--	--	40	30	--	30	6	60	--
Sodium pentachlorophenate and sodium chromate; chemical ratio 3.24:1	Canal	.41	.47	.44	10	--	--	--	--	--	20	80	10	100	11.1
	La.	.41	.47	.44	10	--	--	--	--	--	--	100	10	100	15.6
	Fla.	.40	.47	.44	9	--	--	--	44	--	--	56	5	56	--
	Miss.	.40	.47	.44	10	--	--	--	--	--	--	100	10	100	23.0
Sodium pentachlorophenate and borax; chemical ratio 1:0.76	Canal	.54	.62	.58	10	--	--	--	--	--	--	100	10	100	12.8
	La.	.54	.62	.58	9	--	--	--	--	11	--	89	9	100	11.4
	Fla.	.53	.62	.57	8	--	--	--	--	--	--	100	8	100	17.9
	Miss.	.54	.61	.58	10	--	--	--	--	20	--	80	10	100	21.0
1:2	Canal	.71	.80	.75	10	--	--	--	--	--	--	100	10	100	12.2
	La.	.71	.81	.75	10	--	--	--	--	10	--	90	10	100	9.9
	Fla.	.72	.82	.76	10	--	--	--	--	--	--	100	10	100	12.9
	Miss.	.71	.80	.75	10	--	--	--	--	--	--	100	10	100	18.8
1:1.52	Canal	.78	.88	.83	10	--	--	--	--	50	--	50	10	100	13.0
	La.	.77	.88	.83	10	--	--	--	--	40	--	70	10	100	10.0
	Fla.	.79	.86	.82	9	--	--	--	--	--	--	100	9	100	16.7
	Miss.	.79	.87	.83	10	--	--	--	--	--	--	100	10	100	18.9
1:3	Canal	.91	1.06	.98	10	--	--	--	--	--	--	100	10	100	11.5
	La.	.90	1.07	.98	10	--	--	--	--	10	--	90	10	100	9.0
	Fla.	.92	1.05	.98	10	--	--	--	--	--	--	100	10	100	13.2
	Miss.	.92	1.06	.98	10	--	--	--	--	10	--	90	10	100	16.1
1:2.27	Canal	1.00	1.19	1.09	10	--	--	--	--	--	--	100	10	100	12.7
	La.	1.01	1.16	1.09	10	--	--	--	--	20	--	80	10	100	9.9
	Fla.	1.01	1.18	1.09	10	--	--	--	--	--	--	100	10	100	15.6
	Miss.	1.01	1.18	1.09	10	--	--	--	--	--	--	100	10	100	18.6
1:1.50	Canal	1.17	1.32	1.25	10	--	--	--	--	10	--	90	10	100	12.8
	La.	1.17	1.32	1.25	10	--	--	--	--	--	--	100	10	100	14.6
	Fla.	1.17	1.32	1.25	10	--	--	--	20	19	--	70	8	80	20.0
	Miss.	1.17	1.33	1.25	10	--	--	--	--	10	10	80	10	100	20.9

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Table 5.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.) treated with chlorinated phenols and coal-tar creosote, after 15 to 36 years of service. Stakes placed in test at Barro Colorado Island, Canal Zone, February 1941; Bogalusa, La., March 1941; Jacksonville, Fla., March 1941; and Harrison Experimental Forest, Saurier, Miss., February 1941--continued

Preservative	Loca- tion	Retention of preservative ¹			Number in test ²	Condition of stakes December 1976 ³						Total removed	Average life			
		Minimum	Maximum	Average		Good	Serviceable but showing some--	Destroyed by--								
								Decay	Termite	Decay fungi	attack			fungi		
															and	and
		Pct	Pct	Pct		Pct	Pct	Pct	Pct	Pct	Pct	Num- ber	Pct	Yr		
5 pct pentachlorophenol in fuel oil ⁴	Canal:	4.0	5.4	4.7	10	--	--	--	--	40	--	60	10	100	13.0	
	La.:	4.0	5.4	4.8	10	--	--	--	--	--	--	100	10	100	16.6	
	Fla.:	4.0	5.6	4.8	10	--	--	--	--	40	--	60	6	60	20.0	
	Miss.:	4.2	5.4	4.7	10	--	--	--	--	--	--	100	10	100	21.0	
	Canal:	8.6	10.5	9.6	10	--	--	--	--	30	--	70	10	100	14.4	
	La.:	8.4	10.9	9.6	7	--	--	--	--	57	--	43	3	43	--	
	Fla.:	8.8	10.5	9.6	9	--	--	--	--	67	--	33	3	33	--	
	Miss.:	8.6	10.5	9.6	10	--	--	--	--	10	10	80	9	90	--	
	Canal:	14.0	16.5	15.3	10	--	--	--	--	40	10	--	50	6	60	5.15
	La.:	14.2	16.3	15.3	7	--	--	--	--	100	--	--	--	--	--	--
	Fla.:	14.2	16.3	15.3	10	--	--	--	--	100	--	--	--	--	--	--
	Miss.:	14.0	16.3	15.3	10	--	--	--	--	70	20	--	10	3	30	--
3 pct pentachlorophenol + 2 pct chloro-2-phenylphenol in fuel oil ⁴	Canal:	18.6	21.5	20.1	10	--	--	--	--	100	--	--	--	--	--	
	La.:	18.2	21.7	20.1	7	--	--	--	--	100	--	--	--	--	--	
	Fla.:	18.2	21.7	20.1	9	--	22	--	--	78	--	--	--	--	--	
	Miss.:	18.2	21.9	20.0	10	--	--	--	--	90	--	--	10	1	10	--
	Canal:	4.2	5.8	4.9	10	--	--	--	--	20	--	80	10	100	12.6	
	La.:	4.4	5.8	4.9	10	--	--	--	--	--	--	100	10	100	14.2	
	Fla.:	4.4	5.8	4.9	9	--	--	--	--	22	--	78	7	78	20.0	
	Miss.:	4.2	5.8	4.9	10	--	--	--	--	--	--	100	10	100	19.2	
	Canal:	9.1	10.9	10.0	10	--	--	--	--	50	--	50	10	100	13.7	
	La.:	9.1	10.9	10.0	6	--	--	--	--	67	--	33	2	33	--	
	Fla.:	8.9	11.0	10.0	8	--	--	--	--	75	--	25	2	25	--	
	Miss.:	8.9	11.0	10.0	10	--	--	--	--	10	--	90	10	100	24.4	
Coal-tar creosote, grade 1	Canal:	14.2	16.3	15.4	10	--	--	--	--	10	10	80	9	90	5.12	
	La.:	13.8	16.3	15.3	6	--	--	--	--	100	--	--	--	--	--	
	Fla.:	13.8	16.3	15.3	9	--	--	--	--	100	--	--	--	--	--	
	Miss.:	14.4	16.1	15.3	10	--	--	--	--	30	30	40	7	70	--	
	Canal:	3.5	6.7	4.7	10	--	--	--	--	10	90	--	9	90	5.12	
	La.:	3.3	6.7	4.7	6	--	--	--	--	33	--	67	4	67	5.22	
	Fla.:	3.3	6.5	4.7	9	--	--	--	--	33	33	34	6	67	5.19	
	Miss.:	3.5	6.5	4.6	10	--	--	--	--	--	40	--	60	10	100	21.3
	Canal:	8.4	11.6	10.0	10	--	60	--	--	20	10	--	10	2	20	5.20
	La.:	8.6	11.2	10.0	4	--	--	--	--	75	--	25	1	25	--	
	Fla.:	8.6	11.4	10.0	10	--	--	--	--	90	10	--	--	1	10	--
	Miss.:	8.4	11.4	10.0	10	--	--	--	--	40	40	--	20	6	60	--
Fuel oil ⁴	Canal:	13.5	15.4	14.4	10	10	90	--	--	--	--	--	--	--	--	
	La.:	13.5	15.9	14.5	6	50	16	17	17	--	--	--	--	--	--	
	Fla.:	13.5	15.9	14.5	9	22	56	--	22	--	--	--	--	--	--	
	Miss.:	13.3	16.1	14.5	10	10	--	--	90	--	--	--	--	--	--	
	Canal:	8.2	11.9	9.9	10	--	--	--	--	--	--	60	40	10	100	5.9
	La.:	8.4	11.7	9.8	10	--	--	--	--	--	40	--	60	10	100	8.4
	Fla.:	8.2	11.7	9.8	8	--	--	--	--	--	12	--	88	8	100	9.7
	Miss.:	8.2	11.7	9.8	10	--	--	--	--	--	20	10	70	10	100	6.3
	Canal:	18.2	21.0	19.4	10	--	--	--	--	--	--	30	70	10	100	7.8
	La.:	18.2	21.4	19.4	10	--	--	--	--	--	50	--	50	10	100	11.9
	Fla.:	18.2	21.4	19.4	9	--	--	--	--	--	--	100	9	100	12.4	
	Miss.:	18.0	21.9	19.4	10	--	--	--	--	--	30	10	60	10	100	9.1

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Table 2.—Seedling height of southern pine stakes (2 x 4 in. for red x 1 in. for white) treated with different chemicals and held in storage for 1 year before use. Stakes were in test at Barro Colorado Island, Canal Zone, January 1947; Bogalusa, La., March 1947; Jacksonville, Fla., March 1947; and Morris Experimental Forest, Salem, Mass., January 1947.—continued

Preservation	Location	Retention of preservative ¹		Number tested	Condition of status	December 1976 ³										Total removed	Average life
		Minimum	Maximum			Destroyed by											
						Survived	Survived	Survived	Survived	Survived	Survived	Survived	Survived	Survived	Survived		

¹-Based upon weight of dry chemical for sodium pentachlorophenate alone or mixed with other chemicals and on weight of solution for other treatments. Values for stakes originally installed.

²10 stakes were originally installed in test. This number has since been reduced either because of failure to locate the stakes at the time of the inspection or because of damage by fire.

1. Investigations at Canal Zone January 1956, at Jacksonville December 1960, and at Bogalusa December 1962.

⁴ Purchased and reported earlier as No. 2 fuel oil but has since been found to have a distillation range lower than that for typical No. 2 fuel oils.

⁵ Estimate based upon percentage stakes remaining after final inspection.

6. 100 gms contained 1 part soybean oil and 9 parts each of fuel oil and naptha by volume.

1 reactions contained some heartwood.

Table 6.--Condition of southern pine stakes of different sizes, treated with coal-tar creosote, toluene, and creosote-toluene mixtures, after 35-1/2 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., May 1941

[illegible]

1-Creosote only.

Table 9. --Condition of southern pine stakes (2 x 4 in. nominal x 18 in.) treated with copper arsenate and copper chromate by the double-diffusion process, after about 35 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., February 1942

Treatment	Calculated retention of chemical ^{1,2}				Num: Condition of stakes December 1976										Total		Average
	Copper as CuSO_4	Chromium as Na_2CrO_4	Arsenic as Na_2HAsO_4	Total	ber	in	Good	Serviceable but showing some	Destroyed by--	Decay	Termite	fungi	and	attack	removed	life	
	Pct	Pct	Pct	Pct			Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Num: ber	Pct: Yr	
6-day soak in 10.6 pct copper sulfate solution plus:																	
6-day soak in 9.8 pct sodium arsenate solution	0.66 (.33)	--	0.59 (0.36)	1.25 (0.69)	10	100	--	--	--	--	--	--	--	--	--	--	--
12-day soak in 9.8 pct sodium arsenate solution	.66 (.33)	--	.75 (.46)	1.41 (.79)	10	80	20	--	--	--	--	--	--	--	--	--	--
12-day soak in 11.8 pct sodium chromate solution	.66 (.33)	2.58 (1.59)	--	3.24 (1.92)	10	100	--	--	--	--	--	--	--	--	--	--	--
3-day soak in 10.6 pct copper sulfate solution plus:																	
6-day soak in 9.8 pct sodium arsenate solution	.88 (.44)	--	.55 (.34)	1.43 (.78)	10	100	--	--	--	--	--	--	--	--	--	--	--
6-day soak in 11.8 pct sodium chromate solution	.88 (.44)	1.57 (.97)	--	2.45 (1.41)	10	100	--	--	--	--	--	--	--	--	--	--	--
3-day soak in 5.3 pct copper sulfate solution plus:																	
6-day soak in 4.9 pct sodium arsenate solution	.31 (.15)	--	.17 (.10)	.48 (.25)	10	50	50	--	--	--	--	--	--	--	--	--	--
6-day soak in 5.9 pct sodium chromate solution	.31 (.15)	.50 (.31)	--	.81 (.46)	10	60	--	--	20	--	20	--	4	40	--	--	--
Untreated controls	--	--	--	--	10	--	--	--	20	80	10	100	1.9				

¹Retentions based on chemical analyses made on 2 stakes treated in each charge with those placed in test.

²Retention values in parentheses are oxides ($\text{CuO} - \text{CrO}_3 - \text{As}_2\text{O}_5$).

Table 10.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with urea, after about 11 to 16-1/2 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., February 1942 and December 1946, and at Madison, Wis., April 1942

Treatment	Loca- tion	Total retention	Average retention	Num- ber	Condition of stakes late in 1958						Total removed	Average life
		of urea or solids ¹	of urea or solids ¹	in test	Good	Serviceable but showing some decay	Destroyed by--	Decay	Termite	fungi		
								fungi	and	termite		
								attack	attack			
		Lb	Pcf		Pct	Pct	Pct	Pct	Pct	Num- ber	Pct	Yr
INSTALLED 1942												
2 days' soaking ²	Miss.	4.7	3.4	10	--	--	10	90	10	100	3.4	
	Wis.	4.7	3.4	10	--	--	100	--	--	10	100	8.1
4 days' soaking ²	Miss.	6.9	5.0	10	--	--	20	80	10	100	3.3	
	Wis.	6.9	5.0	10	--	--	100	--	--	10	100	8.0
6 days' soaking ²	Miss.	10.2	7.4	10	--	--	20	80	10	100	2.9	
	Wis.	10.2	7.4	10	--	--	100	--	--	10	100	6.0
B ₁ ³ (thermosetting) 2 days' soaking	Miss.	9.9	7.1	10	--	--	20	80	10	100	4.5	
	Wis.	9.9	7.1	10	--	--	10	--	--	10	100	12.5
B ₁ ³ (thermosetting) 4 days' soaking	Miss.	11.2	8.1	10	--	--	--	100	10	100	5.1	
	Wis.	11.2	8.1	10	--	--	100	--	--	10	100	13.1
B ₁ ³ (thermosetting) 6 days' soaking	Miss.	11.7	8.4	10	--	--	10	90	10	100	5.6	
	Wis.	11.7	8.4	10	--	--	100	--	--	10	100	15.2
Untreated controls	Miss.	--	--	10	--	--	20	80	10	100	1.8	
	Wis.	--	--	10	--	--	100	--	--	10	100	4.8
INSTALLED 1946												
Urea resin, pressure ⁴	Miss.	--	5.8	10	--	--	10	--	90	10	100	9.1

¹Calculated total retention of urea or solids for 22 stakes.

²Treating solution made up to 1.15 parts of urea to 1.00 part of water by weight.

³Solution made up of 380 parts urea, 344 parts of 37 pct formaldehyde solution, 231 parts of water, 6 parts of sodium hydroxide, and 39 parts of borax by weight.

⁴Treated with buffered urea-formalin mix (2 to 1 formaldehyde-urea ratio) at a resin solids content of 30 pct.

Table 11.--Condition of high-strength laminated paper plastic (papreg) stakes (1/8 x 4 x 14 in.) and heat-stabilized plywood (staypak) stakes (4 x 18 in.) of several thicknesses after 7 to 8 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss.

Stake No.:	Composition	Num-ber:	Condition of stakes December 1950						Average life
:	:	in :	Destroyed by--						:
:	:	test:							:
:	:	:	Decay	Termite	Decay fungi	and termite	attack	:	:
:	:	:	fungi	attack	and termite	attack	:	:	:
:	:	:	:	:	:	:	:	:	:
:	:	:	Number:	Pct	Number:	Pct	Number:	Pct	Yr
LAMINATED PAPER PLASTIC (PAPREG)--INSTALLED DECEMBER 2, 1942									
1 to 10	37.0 pct phenolic resin ¹ + 2 pct hardener,	10	7	70	--	--	3	30	7.4
	4.7 pct volatile matter	:	:	:	:	:	:	:	:
11 to 20	31.6 pct phenolic resin ¹ + 2 pct hardener,	10	3	30	1	10	6	60	5.6
	4.4 pct volatile matter	:	:	:	:	:	:	:	:
21 to 30	41.0 pct phenolic resin ¹ + 2 pct hardener,	10	7	70	--	--	3	30	8.0
	4.6 pct volatile matter	:	:	:	:	:	:	:	:
31 to 40	37.0 pct phenolic resin ¹ + 2 pct hardener,	10	7	70	--	--	3	30	7.2
	4.7 pct volatile matter with surface	:	:	:	:	:	:	:	:
	sheets using 42.6 pct phenolic resin, ¹	:	:	:	:	:	:	:	:
	4.6 pct volatile matter ²	:	:	:	:	:	:	:	:
41 to 50	37.0 pct phenolic resin ¹ + 0.5 pct oleic	10	4	40	1	10	5	50	7.6
	acid, 4.7 pct volatile matter	:	:	:	:	:	:	:	:
HEAT-STABILIZED PLYWOOD (STAYPAK)--INSTALLED JUNE 4, 1943									
19-1 and	20 plies 1/16-in. birch bonded with phenolic	2	--	--	1	50	1	50	4.5
19-2	resin and compressed to thickness of	:	:	:	:	:	:	:	:
	1/2 in.; specific gravity 1.37	:	:	:	:	:	:	:	:
HEAT-STABILIZED PLYWOOD (STAYPAK)--INSTALLED DECEMBER 6, 1943									
S-1 to	32 plies 1/16-in. birch bonded with phenolic	5	2	40	--	--	³ 3	60	6.0
S-5	resin and compressed to thickness of	:	:	:	:	:	:	:	:
	1 in., specific gravity 1.33	:	:	:	:	:	:	:	:
21-1 to	10 plies 1/8-in. maple bonded with phenolic	5	--	--	--	--	5	100	4.3
21-5	resin and compressed to thickness of	:	:	:	:	:	:	:	:
	5/8 in.; specific gravity 1.36	:	:	:	:	:	:	:	:

¹Alcohol-soluble.

²Single surface sheet on each side, coated side out.

³Heavy swelling at edges due to moisture absorption.

Table 12.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with phenyl mercury oleate, pentachlorophenol, copper naphthenate, and mercuric chloride, at final inspection after 20 years of service. Stakes placed in test December 1943 on the Harrison Experimental Forest, Saucier, Miss.

Preservative	Treatment	Average retention of solution	Number in test	Condition of stakes December 1963								Total removed	Average life	
				Good	Serviceable but showing some	Decayed by termite attack	but not decayed by termite attack	Decayed by fungi	but not decayed by fungi	Decayed by termite and fungi	but not decayed by termite and fungi			
		Pct		Pct	Pct	Pct	Pct	Pct	Pct	Pct	Number	Pct	Yr	
Phenyl mercury oleate (percentage in naphtha solvent):														
0.4	3-min. dip	1.40	10	--	--	--	--	--	20	80	10	100	3.8	
.4	18-hr. soaking	3.20	10	--	--	--	--	10	30	60	10	100	5.0	
.4	Pressure	5.90	10	--	--	--	--	--	10	90	10	100	6.7	
.4do.....	12.10	10	--	--	--	--	--	30	--	70	10	100	8.8
.2	18-hr. soaking	3.10	10	--	--	--	--	10	30	60	10	100	4.4	
.2	Pressure	6.00	10	--	--	--	--	--	30	70	10	100	5.6	
.2	.....do.....	11.80	10	--	--	--	--	--	30	70	10	100	6.2
.1	18-hr. soaking	3.60	10	--	--	--	--	--	40	60	10	100	4.5	
.1	Pressure	5.90	10	--	--	--	--	--	30	70	10	100	4.7	
.1	.....do.....	11.60	10	--	--	--	--	--	40	60	10	100	5.2
$\frac{1}{4}$	3-min. dip	1.20	10	--	--	--	--	--	60	40	10	100	4.0	
$\frac{1}{1}$	18-hr. soaking	6.00	10	--	--	--	--	--	20	80	10	100	5.5	
$\frac{1}{1}$	Pressure	6.10	10	--	--	--	--	10	40	50	10	100	6.2	
$\frac{1}{1}$	.....do.....	12.00	10	--	--	--	--	--	10	90	10	100	8.4
Pentachlorophenol (5.0 pct in pine-oil naphtha (1:12) solvent)	.....do.....	12.10	10	--	--	--	40	20	--	40	6	60	$\frac{2}{20}$
Copper naphthenate (0.5 pct copper metal in naphtha solvent)	.....do.....	13.10	10	--	--	--	70	20	--	10	3	30	$\frac{2}{25}$
Mercuric chloride (1.0 pct in water)	3-min. dip	.014 (dry salt)	10	--	--	--	--	--	50	50	10	100	4.8	
	18-hr. soaking	.072 (dry salt)	10	--	--	--	--	--	20	80	10	100	7.5	
Untreated controls	--	--	10	--	--	--	--	--	60	40	10	100	2.0	

¹Solution contained 16 pct solids as a water repellent.

²Estimate based on percentage stakes remaining after final inspection.

NOTE--The stakes remaining in test after the 1952 inspection were taken up and reset in the same general area.

Table 13.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with fire-retardant chemicals, after 7 years of service. Stakes placed in test December 1943 on the Harrison Experimental Forest, Saucier, Miss., and inspected December 1950

Treating chemicals	Retention: Num- of	Condition of stakes December 1950	Average life
	dry salt : in	Destroyed by--	
	test:		
		Termite : Decay fungi : attack : and termite : attack	
	Pcf	Number: Pct	Yr
Ammonium sulfate, 78 parts; ammonium phosphate, 19 parts; and sodium dichromate, 3 parts (by weight)	3.01 : 10 : 5 : 50 : 5 : 2.4 6.17 : 10 : 6 : 60 : 4 : 3.4		
Ammonium phosphate, 10 parts; ammonium sulfate, 60 parts; borax, 10 parts; and boric acid, 20 parts (by weight)	2.98 : 10 : 5 : 50 : 5 : 3.9 6.19 : 10 : 2 : 20 : 8 : 4.3		
Borax, 60 parts; and boric acid, 40 parts (by weight)	3.01 : 10 : 3 : 30 : 7 : 6.0 6.29 : 10 : 6 : 60 : 4 : 6.5		
Untreated controls	-- : 10 : 2 : 20 : 8 : 2.2		

Table 14.—Condition of southern pine sapwood stakes (2 x 4 in. nominal x 18 in.), treated with various chemicals, and of laminated acetylated yellow birch sapwood stakes (0.4 x 3-1/2 x 15-3/4 in.), after 32 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., December 1944

Preservative ¹	Average retention of preservative or dry salt	Num-ber	Condition of stakes December 1976								Total removed	Average life
			in Good	Serviceable but showing some	Destroyed by—	Decay	Termite	Decay	Fungi	attack		
						Decay	Termite	Decay	Fungi	attack		
						attack	and	attack	and	attack		
						attack	termite	attack	termite	attack		
	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Num-ber	Pct	Yr
PINE STAKES												
Ammoniacal copper arsenate (Fed. Spec. TT-W-549) (percentage in solution)												
0.612 (0.59)	0.25 (.24)	10	—	10	—	60	30	—	—	3	30	—
1.29 (1.24)	.53 (.51)	10	—	100	—	—	—	—	—	—	—	—
2.57 (2.48)	1.00 (.97)	10	100	—	—	—	—	—	—	—	—	—
3.21 (3.10)	1.29 (1.25)	10	100	—	—	—	—	—	—	—	—	—
Amyl phenyl acetate (percentage in Stoddard solvent)												
0.37	.10	10	—	—	—	—	—	—	—	100	10	6.7
.93	.25	10	—	—	—	—	—	—	—	100	10	8.5
1.85	.50	10	—	—	—	—	—	40	60	10	100	10.0
Capric acid (percentage in Stoddard solvent)												
0.37	.10	10	—	—	—	—	10	30	60	10	100	5.0
.93	.25	10	—	—	—	—	10	20	70	10	100	5.3
1.84	.50	10	—	—	—	—	—	10	90	10	100	5.5
Diamyl phenol (percentage in Stoddard solvent)												
0.37	.10	10	—	—	—	—	—	10	90	10	100	5.8
.90	.25	10	—	—	—	—	—	10	90	10	100	8.4
1.76	.51	10	—	—	—	—	—	10	90	10	100	11.4
DDT (Dichloro-diphenyl-trichloroethane) (percentage in Stoddard solvent)												
1.25	.35	10	—	—	—	—	100	—	—	10	100	7.1
2.7	.74	10	—	—	—	—	70	—	30	10	100	9.0
Dodecyl amine (percentage in Stoddard solvent)												
0.37	.10	10	—	—	—	—	—	20	80	10	100	5.4
.93	.25	10	—	—	—	—	—	—	100	10	100	5.7
1.85	.50	10	—	—	—	—	—	10	90	10	100	6.8
Nickel stearate (percentage in coal-tar naphtha)												
0.33	.10	10	—	—	—	—	10	—	90	10	100	5.6
.93	.27	10	—	—	—	—	30	—	70	10	100	4.9
1.85	.52	10	—	—	—	—	10	10	80	10	100	5.5
Untreated controls	—	10	—	—	—	—	—	40	60	10	100	2.1
YELLOW BIRCH (LAMINATED) ³												
Acetylated	—	10	—	—	—	—	90	—	10	10	100	17.5
Untreated controls	—	10	—	—	—	—	10	20	70	10	100	2.7

¹All stakes except laminated yellow birch were pressure treated.

²Ammoniacal copper arsenate solution and retention figures in parentheses are oxides (CuO and As₂O₅).

³Prepared from 6-ply, parallel-laminated, acetylated 1/16-in. veneer glued with hot-press phenolic resin. Average acetyl content 19.2 pct based upon oven-dry weight of wood. Untreated controls prepared from untreated veneer.

NOTE—The stakes remaining in test after the 1952 inspection were reset in the same general area.

Table 15.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.) treated with acid copper chromate, chromated copper arsenate type I, and nickel-arsenic-chromium salts, after 31 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., December 1945

Preservative	Average retention	Num-ber	Condition of stakes December 1976				Total removed	Average life
			in Good	Serviceable but showing some--	Destroyed by--			
		test						
					Decay:Termite: Decay			
					:fungi:attack: fungi			
					:attack: and			
					:termite:			
					:attack:			
					:attack:			
	Pct		Pct	Pct	Pct	Pct	Num-ber	Yr
Acid copper chromate (Fed. Spec. TT-W-546)	0.26 (0.13)	10	--	--	10	30	60	10 : 100 : 11.6
	.52 (.26)	10	--	--	80	10	10	2 : 20 : --
	.75 (.37)	10	10	40	20	30	--	3 : 30 : --
Chromated copper arsenate type I (Fed. Spec. TT-W-550)	.26 (.15)	10	--	--	30	10	60	7 : 70 : --
	.50 (.29)	10	20	60	20	--	--	-- : -- : --
	.78 (.44)	10	80	20	--	--	--	-- : -- : --
Nickel-arsenic-chromium salts (nickel sulfate (NiSO ₄ · 6H ₂ O), 5.5 parts; sodium arsenate (NaHAsO ₄ · 12H ₂ O), 4.0 parts; arsenic acid (H ₃ AsO ₄), 1.5 parts; and sodium dichromate (Na ₂ Cr ₂ O ₇ · 2H ₂ O), 3.0 parts)	.26 (.16)	10	--	--	10	30	60	10 : 100 : 17.4
	.50 (.32)	10	--	--	90	--	10	1 : 10 : --
	.77 (.50)	10	--	10	90	--	--	-- : -- : --
Untreated controls	--	10	--	--	--	10	30	60 : 10 : 100 : 3.2

¹Retention values in parentheses based on preservative oxides.

Table 17.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with various petroleum oils, pentachlorophenol solution copper naphthenate solutions, coal-tar creosote, and mixtures of these preservatives, after about 20-1/2 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., and at Bogalusa, La., April 1948

Oil or preservative	Loca- tion	Average retention	Number in test	Condition of stakes December 1976 ²										Total removed	Average life
				Good	Serviceable but showing some--	Decayed	Termite decay	Decay fungi	Termite decay	Decay fungi	Termite decay	Decay fungi	Termite decay		
				Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Num- ber	Yr
Unfortified petroleum oil:															
Commercial aromatic solvent (Mid-United States)	:Miss.: :La.:	4.1 4.1	10 10	-- --	-- --	-- --	-- --	10 --	-- --	90 20	10 80	100 100	2.4 2.9		
Stoddard solvent (Mid-United States)	:Miss.: :La.:	4.0 4.0	10 10	-- --	-- --	-- --	-- --	10 10	20 20	70 70	10 10	100 100	2.2 2.8		
No. 2 fuel oil (Mid-United States)	:Miss.: :La.:	4.1 4.0	10 10	-- --	-- --	-- --	-- --	10 70	10 --	80 30	10 10	100 100	4.4 4.1		
Heavy thermal side cut (Mid-United States)	:Miss.: :La.:	4.2 4.2	10 10	-- --	-- --	-- --	-- --	-- 30	10 --	90 70	10 10	100 100	3.5 4.6		
No. 200 Diesel oil (West Coast)	:Miss.: :La.:	4.0 4.0	10 10	-- --	-- --	-- --	-- --	20 80	20 --	60 20	10 10	100 100	4.8 4.6		
Catalytic gas-base oil (West Coast)	:Miss.: :La.:	4.0 4.0	10 10	-- --	-- --	-- --	-- --	40 60	-- --	60 40	10 10	100 100	7.6 7.7		
	:Miss.: :La.:	8.0 8.0	10 10	-- --	-- --	-- --	-- --	30 50	-- 20	70 20	10 4	100 40	14.6 --		
	:Miss.: :La.:	12.0 11.9	10 8	-- --	-- 25	-- --	-- 63	40 12	-- --	60 --	10 1	100 12	17.1 --		
No. 300 fuel oil (West Coast)	:Miss.: :La.:	4.2 4.2	10 10	-- --	-- --	-- --	-- 20	90 80	-- --	10 --	10 8	100 80	7.1 6.5		
No. 400 fuel oil (West Coast)	:Miss.: :La.:	4.2 4.2	10 10	-- --	-- --	-- --	-- --	80 90	-- --	20 10	10 10	100 100	5.8 5.5		
Light gas oil (Mid-United States)	:Miss.: :La.:	4.1 4.1	10 10	-- --	-- --	-- --	-- --	50 60	-- --	50 40	10 10	100 100	6.7 6.0		
Denver No. 3 blend (50-50 topped crude residual and recycled overhead gas oil)	:Miss.: :La.:	4.0 4.0	10 10	-- --	-- --	-- --	-- --	60 80	-- --	40 20	10 10	100 100	6.5 5.9		
Heavy gas oil (Mid-United States)	:Miss.: :La.:	4.0 4.0	10 10	-- --	-- --	-- --	-- 60	100 40	-- --	-- 4	10 40	100 40	12.9 --		
	:Miss.: :La.:	7.9 7.9	10 9	-- --	-- 33	-- --	-- 67	30 --	70 --	-- --	7 --	70 --	-- --		
	:Miss.: :La.:	12.1 12.1	10 5	-- --	-- 60	-- 40	-- --	80 --	10 --	-- --	1 --	10 --	-- --		
Lube oil extract (Texas)	:Miss.: :La.:	4.1 4.2	10 8	-- --	-- --	-- --	-- 63	100 25	-- --	-- 12	10 3	100 37	12.0 --		

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Table 17.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with various petroleum oils, pentachlorophenol solution copper naphthenate solutions, coal-tar creosote, and mixtures of these preservatives, after about 78-1/2 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., and at Bogalusa, La., April 1948--continued

Oil or preservative	Loca- tion	Average retention	Number in test	Condition of stakes December 1976 ²										Total removed	Average life
				Good	Serviceable but showing some--	Destroyed by--	Decay	Termite	Decay	fungi	attack	fungi	and		
							attack	and	termite	and	termite	attack			
		Pct		Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Num- ber	Pct	Yr
Fortified petroleum oils and mixtures:															
Commercial aromatic solvent (Mid-United States) with 5 pct pentachlorophenol	Miss.	4.2	10	--	--	--	--	--	--	--	100	10	100	10.9	
	La.	4.2	10	--	--	--	--	--	10	--	90	10	100	8.5	
Stoddard solvent (Mid-United States) with 5 pct pentachlorophenol	Miss.	4.0	10	--	--	--	--	10	--	--	90	10	100	13.7	
	La.	4.0	10	--	--	--	--	20	--	--	80	10	100	8.8	
No. 2 fuel oil (Mid-United States) with 5 pct pentachlorophenol	Miss.	4.0	10	--	--	--	--	10	10	--	80	10	100	14.9	
	La.	3.8	10	--	--	--	20	--	--	--	80	8	80	12.5	
Heavy thermal side cut (Mid-United States) with 5 pct pentachlorophenol	Miss.	4.0	10	--	--	--	--	20	--	--	80	10	100	14.0	
	La.	4.0	10	--	--	--	--	10	--	--	90	10	100	10.6	
No. 200 Diesel oil (West Coast) with 5 pct pentachlorophenol	Miss.	4.1	10	--	--	--	--	10	--	--	90	10	100	17.0	
	La.	4.1	10	--	--	--	50	--	--	--	50	5	50	--	
Catalytic gas-base oil (West Coast) with 5 pct pentachlorophenol	Miss.	4.1	10	--	--	--	--	--	--	--	100	10	100	16.3	
	La.	4.1	8	--	--	--	88	12	--	--	--	1	12	--	
	Miss.	8.0	10	--	--	--	--	10	--	--	90	10	100	21.3	
	La.	7.9	8	--	12	--	88	--	--	--	--	--	--	--	
	Miss.	12.0	10	--	--	--	40	20	--	--	40	6	60	--	
	La.	12.0	9	--	56	--	44	--	--	--	--	--	--	--	
No. 300 fuel oil (West Coast) with 5 pct pentachlorophenol	Miss.	4.0	10	--	--	--	--	80	--	--	20	10	100	14.6	
	La.	4.1	8	--	12	--	51	12	--	--	25	3	37	--	
No. 400 fuel oil (West Coast) with 5 pct pentachlorophenol	Miss.	4.2	10	--	--	--	--	40	--	--	60	10	100	13.9	
	La.	4.2	9	--	--	--	22	22	--	--	56	7	78	12.5	
Light gas oil (Mid-United States) with 5 pct pentachlorophenol	Miss.	4.0	10	--	--	--	--	--	--	--	100	10	100	15.6	
	La.	4.2	10	--	--	--	50	--	--	--	50	5	50	--	
Denver No. 3 blend (50-50 topped crude residual and recycled overhead gas oil) with 5 pct pentachlorophenol	Miss.	4.0	10	--	--	--	10	70	--	--	20	9	90	--	
	La.	4.0	7	--	--	--	86	14	--	--	20	9	14	--	
Heavy gas oil (Mid-United States) with 5 pct pentachlorophenol	Miss.	4.1	9	--	--	--	67	--	--	--	33	3	33	--	
	La.	4.1	8	--	12	--	88	--	--	--	--	--	--	--	
	Miss.	7.9	10	--	--	--	90	10	--	--	--	1	10	--	
	La.	7.9	6	--	33	--	67	--	--	--	--	--	--	--	
	Miss.	12.0	10	10	30	--	50	10	--	--	--	1	10	--	
	La.	12.0	5	60	--	--	40	--	--	--	--	--	--	--	

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Table 17.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.) treated with various petroleum oils, pentachlorophenol solution copper naphthenate solutions, coal-tar creosote, and mixtures of these preservatives, after about 28-1/2 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., and at Bogalusa, La., April 1948--continued

Oil or preservative	Loca- tion	Average retention	Number in test ¹	Condition of stakes December 1976 ²										Total removed	Average life
				Good	Serviceable but showing some--	Destroyed by--	Decay	Termite	Decay	Fungi	Attack	and	Termite		
		Pct		Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Num- ber	Pct	Yr
Fortified petroleum oils and mixtures:															
--continued															
Lube oil extract (Texas) with 5 pct pentachlorophenol	Miss.	4.2	10	--	--	--	40	50	--	10	6	60	--		
	La.	4.2	8	--	--	--	100	--	--	--	--	--	--		
Catalytic gas-base oil (West Coast) with copper naphthenate (0.5 pct copper metal)	Miss.	4.2	10	--	--	--	--	70	10	20	10	100	14.3		
	La.	4.2	10	--	10	--	60	10	--	20	3	30	--		
Catalytic gas-base oil (West Coast) with copper naphthenate (0.75 pct copper metal)	Miss.	4.4	8	--	--	--	--	75	--	25	8	100	17.4		
	La.	4.2	8	13	13	--	62	12	--	--	1	12	--		
Coal-tar creosote		4.1	10	--	--	--	--	70	--	30	10	100	14.2		
		4.1	10	--	--	--	50	40	--	10	5	50	--		
Coal-tar creosote, 50 pct, and catalytic gas-base oil (West Coast) with 5 pct pentachlorophenol, 50 pct by volume	Miss.	4.1	10	--	--	--	10	50	--	40	9	90	--		
	La.	4.1	8	--	--	--	62	--	--	38	3	38	--		
Coal-tar creosote, 50 pct, and catalytic gas-base oil (West Coast) with copper naphthenate (0.5 pct copper metal) 50 pct by volume	Miss.	4.2	10	--	--	--	10	90	--	--	9	90	--		
	La.	4.3	10	--	--	--	90	10	--	--	1	10	--		
Coal-tar creosote, 25 pct, and catalytic gas-base oil (West Coast) with copper naphthenate (0.75 pct copper metal), 75 pct by volume	Miss.	4.1	10	--	--	--	--	90	--	10	10	100	14.6		
	La.	4.2	8	--	--	--	50	38	--	12	4	50	--		
Catalytic gas-base oil (West Coast) with 5 pct pentachlorophenol, 50 pct, and catalytic gas-base oil (West Coast) with copper naphthenate (0.5 pct copper metal), 50 pct by volume	Miss.	4.2	10	--	--	--	30	20	10	40	7	70	--		
	La.	4.2	9	--	--	--	100	--	--	--	--	--	--		
Untreated controls	Miss.	--	10	--	--	--	--	20	20	60	10	100	2.2		
	La.	--	10	--	--	--	--	--	--	100	10	100	2.8		

¹10 stakes were originally installed at each test station. This number has since been reduced because of failure to locate the stakes at the time of inspection.

²Final inspection at Bogalusa November 1962.

³Estimate based on percentage of stakes remaining after final inspection.

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Table 19.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with English coke oven and vertical retort coal-tar creosotes, after about 28 years of service. Stakes placed in test at the Harrison Experimental Forest, Saucier, Miss., December 1948

Preservative	Average:Num-: : : :reten- :ber : : tion : in :Good: Serviceable but : Destroyed by-- : : test : : showing some-- : : : : :Decay:Termite: Decay : : : : : :Decay:Termite: Decay :fungi:attack : fungi : : : : : : :attack : and : : : : : : :termite: : : : : : : :attack :
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Table 20.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with zinc-arsenic chromium and chromated copper arsenate salts, after about 27 years of service. Stakes placed in test at Madison, Wis., November 1949, and on the Harrison Experimental Forest, Saucier, Miss., December 1949

Preservative	Loca- tion	Average retention:	Num- ber	Condition of stakes December 1976								Total removed	Average life
				In Good test	Serviceable but showing some--	Destroyed by--	Decay: Termite:	Decay: fungi:	Decay: Termite:	Decay: fungi:	Decay: Termite:		
				Pct	Pct	Pct	Pct	Pct	Pct	Pct	Num- ber	Pct	Yr
Zinc-arsenic-chromium salt (S 32) ¹	Wis.	(0.96)	10	--	90	--	--	10	--	--	1	10	--
	Miss.	(.96)	10	80	20	--	--	--	--	--	--	--	--
	Wis.	(.74)	10	--	80	--	--	20	--	--	2	20	--
	Miss.	(.72)	10	30	30	--	40	--	--	--	--	--	--
	Wis.	(.50)	10	--	20	--	--	80	--	--	8	80	--
	Miss.	(.50)	10	--	20	--	80	--	--	--	--	--	--
	Wis.	(.35)	10	--	10	--	--	90	--	--	9	90	--
	Miss.	(.35)	10	--	--	--	100	--	--	--	--	--	--
	Wis.	(.22)	10	--	10	--	--	90	--	--	9	90	--
	Miss.	(.22)	10	--	--	--	90	--	--	10	1	10	--
Chromated copper arsenate, type II (Fed. Spec. TT-W-550)	Wis.	(1.03)	10	90	10	--	--	--	--	--	--	--	--
	Miss.	(1.04)	10	100	--	--	--	--	--	--	--	--	--
	Wis.	(.78)	10	100	--	--	--	--	--	--	--	--	--
	Miss.	(.79)	9	100	--	--	--	--	--	--	--	--	--
	Wis.	(.52)	10	30	70	--	--	--	--	--	--	--	--
	Miss.	(.52)	10	100	--	--	--	--	--	--	--	--	--
	Wis.	(.37)	10	--	100	--	--	--	--	--	--	--	--
	Miss.	(.37)	10	100	--	--	--	--	--	--	--	--	--
	Wis.	(.26)	10	--	100	--	--	--	--	--	--	--	--
	Miss.	(.26)	10	30	40	--	30	--	--	--	--	--	--
Zinc chloride	Wis.	1.03(.61)	10	--	--	--	--	100	--	--	10	100	12.8
	Miss.	1.04(.62)	10	--	--	--	--	20	--	80	10	100	16.9
Coal-tar creosote	Wis.	8.4	10	--	90	--	--	10	--	--	1	10	--
	Miss.	8.3	10	--	--	--	90	10	--	--	1	10	--
Untreated controls	Wis.	--	10	--	--	--	--	100	--	--	10	100	7.0
	Miss.	--	10	--	--	--	--	10	30	60	10	100	2.8

¹ZnO, 97 parts; CrO₃, 170 parts; and As₂O₅, 213 parts.

²Retention figures in parentheses are based on preservative oxides.

Table 21.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with two fortified aromatic petroleum oils, after about 27 years of service. Stakes placed in test at the Harrison Experimental Forest, Saucier, Miss., December 1949

[illegible]

¹Reported to be a mixture of heavy petroleum cresylic acids, an aromatic solvent, and copper naphthenate equivalent to 0.3 pct. copper metal.

²Reported to be a mixture of petroleum cresylic acids, aromatic oils, and 1.0 pct. pentachlorophenol.

Table 22.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with oil solutions of rosin amine D pentachlorophenol and pentachlorophenol, after about 27 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., December 1949

Preservative	Average : retention:ber	: Num- : in : : test :	Condition of stakes December 1976										Total : removed	Average : life
			: Good : : Serviceable but : : showing some-- :	: Destroyed by-- :	: Decay:Termite: Decay :	: Decay:Termite: Decay : fungi : : attack : and : and :	: Termite: : : attack : attack :	: Pct : : Pct :	: Pct : : Pct :	: Pct : : Pct :	: Num- : : ber :	: Yr		
Rosin amine D pentachlorophenate, 5 pct, in Stoddard solvent	4.0 : 7.9 : 11.8 :	10 : 10 : 10 :	-- : -- : -- :	-- : -- : -- :	-- : -- : -- :	-- : -- : -- :	-- : -- : -- :	20 : -- : -- :	80 : 100 : 100 :	10 : 10 : 10 :	100 : 10 : 100 :	3.8 : 5.1 : 9.5 :		
Rosin amine D pentachlorophenate, 5 pct; and paraffin wax, 2 pct, in Stoddard solvent	4.2 : 8.0 :	10 : 10 :	-- : -- :	-- : -- :	-- : -- :	-- : -- :	-- : -- :	20 : 10 :	80 : 90 :	10 : 10 :	100 : 100 :	4.5 : 7.8 :		
Rosin amine D pentachlorophenate, 5 pct; paraffin wax, 2 pct; and pentalyn H, 10 pct, in Stoddard solvent	4.0 : 8.0 :	10 : 10 :	-- : -- :	-- : -- :	-- : -- :	-- : -- :	-- : 30 :	30 : 30 :	70 : 40 :	10 : 10 :	100 : 100 :	8.0 : 8.7 :		
Rosin amine D pentachlorophenate, 5 pct, in No. 4 aromatic oil	4.0 : 7.6 : 12.3 :	10 : 10 : 10 :	-- : -- : -- :	-- : -- : -- :	-- : -- : -- :	-- : -- : -- :	-- : -- : 60 :	-- : 50 : 30 :	40 : 50 : 30 :	10 : 10 : 3 :	100 : 100 : 30 :	12.7 : 15.9 : -- :		
Pentachlorophenol, 5 pct; and pine oil, 5 pct, in Stoddard solvent	4.1 : 8.0 :	10 : 10 :	-- : -- :	-- : -- :	-- : -- :	-- : -- :	-- : -- :	-- : -- :	100 : 100 :	10 : 9 :	100 : 100 :	9.5 : 15.5 :		
Pentachlorophenol, 5 pct; pine oil, 5 pct; paraffin wax, 2 pct; and pentalyn H, 10 pct, in Stoddard solvent	4.1 : 7.8 :	10 : 10 :	-- : -- :	-- : -- :	-- : -- :	-- : -- :	-- : 20 :	10 : -- :	90 : 80 :	10 : 10 :	100 : 100 :	12.8 : 15.7 :		
Pentachlorophenol, 5 pct, in No. 4 aromatic oil	4.2 : 8.2 :	10 : 10 :	-- : -- :	-- : -- :	-- : -- :	20 : 80 :	60 : 10 :	-- : -- :	20 : 10 :	8 : 2 :	80 : 20 :	-- : -- :		
Untreated controls	--	10 :	--	--	--	--	--	30 :	70 :	10 : 100 :	2.3			

Table 23.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with rosin amine D pentachlorophenol and pentachlorophenol in petroleum oil (Wyoming residual), after about 25 years of service. Stakes placed in test at the Harrison Experimental Forest, Saucier, Miss., March 1952

Preservative	Average retention : :Pct.	Number in test : :Pct.	Condition of stakes November 1976 : :Pct.	Serviceable but showing some-- : :Pct.	Destroyed by-- : :Pct.	Total removed : :Pct.	Average life : :Yr.
Rosin amine D pentachlorophenol 5 pct., in petroleum oil (Wyoming residual)	4.0 : 8.0 : 12.7 :	10 : 10 : 10 :	-- : -- : -- :	40 : 40 : 70 :	40 : 40 : 20 :	20 : 20 : -- :	6 : 6 : 2 :
Pentachlorophenol, 5 pct. in petroleum oil (Wyoming residual)	4.0 : 8.0 : 11.7 :	10 : 10 : 10 :	-- : -- : 50 : 30 :	10 : 70 : 20 :	50 : 20 : -- :	40 : -- : -- :	9 : 2 : -- :
Petroleum oil (Wyoming residual)	7.7 : 12.2 :	10 : 10 :	-- : -- :	20 : 30 :	60 : 70 :	20 : -- :	8 : 7 :
Untreated controls	-- :	10 :	-- :	-- :	20 : 80 :	100 : 2.0	

Table 24.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with two Boliden salt formulations, after about 25 years of service. Stakes placed in test at the Harrison Experimental Forest, Saucier, Miss., March 1952

Preservative	Average retention (anhydrous salts)	Number in test	Condition of stakes November 1976	Total removed	Average life
			Good : Serviceable : Destroyed by--		
			some--		
			Termite: Decay :		
			Decay: Decay: attack: fungi :		
			and :		
			termite: :		
			attack: :		
	Pct.	Pct.	Pct.	Number	Yr.
Chromated zinc arsenate (H ₃ AsO ₄ , 0.22 ¹ (0.11); 20 parts; Na ₂ HAsO ₄ , 21 parts; Na ₂ Cr ₂ O ₇ ·H ₂ O, 16 parts; and AnSO ₄ , 43 parts) ²	10 : 0.22 ¹ (0.11) : .38 (.20) : .77 (.40) : 1.01 (.53)	10 : 10 : 10 : 10 : 10	-- : -- : -- : -- : --	20 : 100 : 100 : 100 : 100	80 : 80 : 80 : 80 : 80
Boliden salts S-25 (CrO ₃ , 32 parts; CuO, 5 parts; ZnO, 14 parts; and As ₂ O ₅ , 49 parts)	10 : (.30) : (.50) : (.75) : (1.01)	10 : 10 : 10 : 10 : 10	-- : 70 : 30 : 90 : 100	-- : -- : 10 : -- : --	-- : -- : -- : -- : --
Untreated controls	-- : -- : -- : -- : --	10 : 10 : 10 : 10 : 10	-- : -- : -- : -- : --	20 : 80 : 10 : 100 : 100	1.8

¹Retention values in parentheses are based on preservative oxides.

²Retentions are shown on an anhydrous basis, and figures should be increased approximately 26 pct to obtain values as computed in AWP Standard P5-55.

³This stake group placed in test in August 1952.

Table 25.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.) treated with four fire-retardant formulations (AWPA P10-S1), after about 25 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., March 1952¹

Preservative	Average retention	Number in test	Condition of stakes November 1976										Total removed	Average life
			Good	Serviceable but showing some--	Destroyed by--	Decay		Termite		Fungi		Attack		
			Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Num-ber	Yr	
Chromated zinc chloride (ZnCl ₂ , 80.4 parts; Na ₂ Cr ₂ O ₇ • 2H ₂ O, 19.6 parts)	1.50 ² (0.92)	10	--	--	40	20	--	40	6	60	--	--	--	
	2.91 (1.78)	10	20	--	40	10	10	--	2	20	--	--	--	
	6.00 (3.67)	10	50	--	50	--	--	--	--	--	--	--	--	
Chromated zinc chloride (FR) (Chromated zinc chloride, 80 parts; H ₃ BO ₃ , 10 parts; and (NH ₄) ₂ SO ₄ , 10 parts)	1.53	10	--	--	10	30	20	40	9	90	--	--	--	
	3.00	10	--	--	10	60	10	10	3	30	--	--	--	
	6.08	10	10	--	80	10	--	--	--	--	--	--	--	
Minolith (NH ₄) ₂ HPO ₄ , 10 parts; (NH ₄) ₂ SO ₄ , 60 parts; Na ₂ B ₄ O ₇ , 10 parts; and H ₃ BO ₃ , 20 parts)	1.50	10	--	--	--	--	10	90	10	100	3.6			
	3.00	10	--	--	--	--	10	90	10	100	4.8			
	6.13	10	--	--	--	--	30	70	10	100	5.0			
Pyresote (ZnCl ₂ , 35 parts; (NH ₄) ₂ SO ₄ , 35 parts; H ₃ BO ₃ , 25 parts; and Na ₂ Cr ₂ O ₇ • 2H ₂ O, 5 parts)	1.50	10	--	--	--	--	10	90	10	100	11.2			
	3.01	10	--	--	--	--	20	80	10	100	13.0			
	6.26	10	--	--	--	10	20	60	9	90	--			
Untreated controls	--	10	--	--	--	--	20	80	10	100	2.6			

¹In cooperation with Bureau of Ships, Department of the Navy.

²Retention values in parentheses based on preservative oxides.

Table 26.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with basic zinc chloride and zinc chloride, after about 25 years of service. Stakes placed in test at the Harrison Experimental Forest, Saucier, Miss., March 1952

[illegible]

1. Pershall process. Compound intended as fire retardant with retentions of 3-1/2 to 4 pcf.

Retentions of basic zinc chloride are expressed as weight of zinc oxide.

²Retention value in parentheses based on preservative oxide ZnO.

Table 27. --Condition of southern pine stakes (2 x 4 in. nominal x 18 in.) treated with naval-stores products, after about 25 years of service. Stakes placed in test on the Harrison Experimental Forest, Sautter, Miss., March 1952.--continued

Preservative	Average Number: renewal tion	Condition of stakes November 1976	Total removed	Average life
	in test	Good: Serviceable but : Destroyed by-- : showing some--		
		Decay:Termite: Decay:Termite: Decay: : attack: and : attack: fungi: : termite: and : termite: and : attack: attack : attack: attack		
	Pct	Pct	Pct	Pct
	Num	Num	Num	Num
	ber	ber	ber	ber
Oilco resin and Stoddard solvent (1:7) ¹ with 3.11 pct ¹ pentachlorophenol	8.2 : 10	-- : -- : 40 : 10 : 50	10 : 100	10.4
Drop liquor concentrate and Stoddard solvent (1:7) ¹ with 2.99 pct ¹ pentachlorophenol	7.9 : 10	-- : -- : 20 : -- : 80	10 : 100	8.7
Oilco resin and No. 2 fuel oil (1:7) ¹ with 2.94 pct ¹ pentachlorophenol	4.1 : 10 8.0 : 10 12.0 : 10	-- : -- : 50 : -- : 50 -- : -- : 30 : -- : 70 -- : -- : 10 : 20 : 70	10 : 100 10 : 100 9 : 90	10.0 13.5 --
Drop liquor concentrate and No. 2 fuel oil (2:7) ¹	4.0 : 10 8.0 : 10 12.0 : 10	-- : -- : 10 : -- : 90 -- : -- : 20 : -- : 80 -- : -- : -- : -- : 100	10 : 100 10 : 100 10 : 100	6.8 7.8 10.2
Drop liquor concentrate and No. 2 fuel oil (1:7) ¹ with 3.03 pct ¹ pentachlorophenol	4.0 : 10 8.0 : 10 12.0 : 10	-- : -- : 10 : 30 : 60 -- : -- : 20 : -- : 70	10 : 100 9 : 90 9 : 90	12.2 -- --
No. 2 fuel oil with 5 pct ¹ rosin amine D copper acetate complex	4.1 : 10 8.0 : 10 12.1 : 10	-- : -- : 50 : -- : 50 -- : -- : 50 : -- : 30	10 : 100 10 : 100 8 : 80	8.0 9.6 --
Untreated controls	-- : 10	-- : -- : 10 : 20 : 70	10 : 100	2.8

1. Ratios and percentages on a weight basis.

2-1 stake missing, eliminated from test.

Table 28.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with coal-tar creosotes from tars produced by low-temperature carbonization (Disco process) after 24 years of service. Stakes placed in test at the Harrison Experimental Forest, Saucier, Miss., December 1952.

[illegible]

Table 29.--Condition, after about 2 1/2 years of service, of southern pine stakes (2 x 4 in. nominal x 18 in.) treated with preservative oils and conditioned by vapor cleaning and steaming to remove residual solvents. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., April 1953¹

Stake No.	Preservative	Conditioning: after treatment	Number in test	Average preservative retention			Condition of stakes November 1976										Total removed	Average life
				From weights before and after treatment ²	By analysis: 12 months after treat- ment; penta- chloro- phenol or copper metal	Good	Serviceable but showing some--			Destroyed by--								
							Decay	Termite attack	Fungi	Decay	Termite attack	Fungi						
Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Num- ber	Pct	Yr				
V1-V10	Pentachlorophenol	None	10	4.2	0.105	0.082	--	--	--	--	20	10	70	10	100	11.6		
V11-V20	2.5 pct in light aromatic solvent ³	Steaming ⁴	10	4.2	.105	.091	--	--	--	--	10	--	90	10	100	12.4		
V21-V30	Pentachlorophenol	Vapor cleaning ⁵	10	4.1	.102	.069	--	--	--	--	10	10	80	10	100	11.3		
V31-V40	Pentachlorophenol	Steaming ⁴	10	4.4	.200	.139	--	--	--	--	30	--	70	10	100	10.8		
V41-V50	Pentachlorophenol	Vapor cleaning ⁵	10	4.5	.225	.136	--	--	--	--	20	--	80	10	100	14.2		
V51-V60	Pentachlorophenol	None	10	4.6	.230	.186	--	--	--	--	10	--	90	10	100	14.1		
V61-V70	5 pct in light aromatic solvent ³	Steaming ⁴	10	4.8	.240	.222	--	--	--	--	10	--	90	10	100	12.9		
V71-V80	Pentachlorophenol	Vapor cleaning ⁵	10	6.0	.300	.173	--	--	--	--	--	--	10	10	100	12.3		
V81-V90	Pentachlorophenol	Steaming ⁴	10	4.4	.400	.319	--	--	--	20	10	--	70	8	80	--		
V91-V100	Pentachlorophenol	Vapor cleaning ⁵	10	6.0	.600	.397	--	--	--	30	--	--	70	7	70	--		
V101-V110	Pentachlorophenol	None	10	6.2	.310	.121	--	--	--	--	--	--	100	10	100	16.5		
V111-V120	5 pct in No. 2 fuel oil	Steaming ⁴	10	6.6	.330	.146	--	--	--	10	20	--	70	9	90	--		
V121-V130	Vapor cleaning ⁵		10	7.2	.360	.111	--	--	--	--	20	--	80	10	100	13.1		
V131-V140	Copper naphthenate	None	10	4.6	.023	.020	--	--	--	--	50	--	50	10	100	11.0		
V141-V150	0.5 pct copper in light aromatic solvent	Steaming ⁴	10	4.5	.022	.020	--	--	--	--	40	--	60	10	100	12.0		
V151-V160	Vapor cleaning ⁵		10	4.6	.023	.018	--	--	--	--	40	--	60	10	100	11.8		
V161-V170	Copper naphthenate	Steaming ⁴	10	4.4	.026	.023	--	--	--	--	30	--	70	10	100	14.3		
V171-V180	Copper naphthenate	Vapor cleaning ⁵	10	4.2	.029	.021	--	--	--	--	30	--	70	10	100	13.7		
V181-V190	Untreated controls	--	10	--	--	--	--	--	--	--	--	60	40	10	100	2.4		

¹In cooperation with the Bureau of Ships, Department of the Navy.

²Prior to conditioning.

³Solution contained 5 pct ester gum (by weight) as a bloom preventative.

⁴1 hr. steaming with maximum temperature 259° F. and 1 hr. vacuum, following which steaming and vacuum periods were repeated.

⁵1 hr. heating in vapor of aromatic solvent with maximum temperature of 280° F., and 1 hr. vacuum, following which vapor heating and vacuum periods were repeated.

Table 30. — Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with Basilit UA, after about 22 years of service. Stakes placed in test at the Harrison Experimental Forest, Saucier, Miss., December 1954

[illegible]

¹Contains sodium fluoride, sodium dichromate, and sodium arsenate.

²Retention values in parentheses based on preservative oxides.

Table 31.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.) of uninfected and *Trichoderma* mold-infected wood, treated with coal-tar creosote, pentachlorophenol solution, and copperized chromated zinc chloride, after about 22 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., December 1954

Preservative	Average retention	Number in test	Condition of stakes November 1976								Total removed	Average life
			Good	Serviceable but showing some--	Destroyed by--	Decay	Termite	Decay	fungi	attack	fungi	
						and						
						termite						
						attack						
	Pcf		Pct	Pct	Pct	Pct	Pct	Pct	Pct	Num-ber	Pct	Yr
STAKES FROM WOOD WITHOUT MOLD INFECTION												
Coal-tar creosote (high residue, straight-run)	3.9 7.8 12.2	10 10 10	-- -- 20	-- 10 10	-- -- --	70 90 70	30 -- --	-- -- --	-- -- --	3 -- --	30 -- --	-- -- --
Coal-tar creosote (low residue, low in tar acids and naphthalenes)	4.0 8.0 12.4	10 10 10	-- -- 50	-- -- --	-- -- --	50 90 50	10 -- --	-- -- --	-- -- --	40 10 --	5 1 --	50 10 --
Pentachlorophenol (4.7 pct in No. 2 fuel oil)	4.2 8.1 12.1	10 10 10	-- -- --	-- -- --	-- -- --	-- 30 90	10 10 --	20 -- --	70 60 10	10 7 1	100 70 10	16.7 -- --
Copperized chromated zinc chloride	.34 ¹ (0.20) .73 (.45) 1.15 (.71)	10 10 10	-- -- --	-- -- 10	-- 20 80	-- 60 10	-- 20 --	20 -- --	80 -- --	10 2 --	100 20 --	16.6 -- --
Untreated controls	--	10	--	--	--	--	--	60	40	10	100	2.1
STAKES FROM WOOD INFECTED WITH <i>TRICHODERMA</i> MOLD												
Coal-tar creosote (high residue, straight run)	4.0 8.0 12.0	10 10 10	-- -- --	-- -- --	-- -- --	50 80 100	30 20 --	-- -- --	20 -- --	5 1 --	50 10 --	-- -- --
Coal-tar creosote (low residue, low in tar acids and naphthalenes)	4.1 8.0 12.0	10 10 10	-- -- --	-- -- --	-- -- --	20 80 100	60 10 --	-- -- --	20 10 --	8 2 --	80 20 --	-- -- --
Pentachlorophenol (4.7 pct in No. 2 fuel oil)	4.2 7.8 11.9	10 10 10	-- -- --	-- -- --	-- -- --	20 20 80	20 10 10	20 -- --	40 70 10	8 8 2	80 80 20	-- -- --
Copperized chromated zinc chloride	.34 (.20) .74 (.45) 1.17 (.71)	10 10 10	-- -- --	-- -- --	-- 40 80	30 50 20	-- -- --	20 -- --	50 10 --	7 1 --	70 10 --	-- -- --
Untreated controls	--	10	--	--	--	--	10	30	60	10	100	2.5

¹Retention values in parentheses based on preservative oxides.

Table 32,---Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with Texas lignite coal-tar creosote and with paraffin alone and fortified with pentachlorophenol, after 22 years of service. Stakes placed in test at the Harrison Experimental Forest, Saucier, Miss., December 1954

Preservative	Average: Number: retention: in	Condition of stakes November 1976						Total removed	Average: life		
		Good: Serviceable but showing some--	Decay: Termite: Decay: fungi: attack: and termite: attack:	Destroyed by--							
	Pcf.	Pct.	Pct.	Pct.	Pct.	Pct.	Number: Pct.	Yr.			
Texas lignite coal-tar creosote	5.1	10	--	--	20	10	--	70	8	80	--
Do.....	9.8	10	--	--	80	--	--	20	2	20	--
Do.....	15.2	10	20	--	10	--	--	--	--	--	--
25 pct. paraffin in aromatic volatile solvent (by weight)	25.9	10	--	--	10	10	10	70	9	90	--
5 pct. pentachlorophenol plus 28.5 pct. paraffin in aromatic volatile solvent (by weight)	26.3	10	10	--	30	60	--	--	--	--	--
Untreated controls	--	10	--	--	--	--	30	70	10	100	2.3

Table 33.--Condition of Douglas-fir, sweetgum, and tangle plywood stakes, treated with pentachlorophenol and with fluor chrome arsenate phenol type A, after about 21 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., January 1956¹

Item No.	Species	Preservative	Treatment	Average retention	Num-ber	Condition of stakes November 1976						Total removed	Average life
						In Good test	Serviceable but showing some--	Destroyed by--	Decay	Termite	Decay		
									fungi	attack	fungi		
									and		and		
									termite		termite		
									attack		attack		
				Pct		Pct	Pct	Pct	Pct	Pct	Pct	Num-ber	Pct Yr
PLYWOOD FROM VENEER TREATED BEFORE GLUING													
1	Douglas-fir	Pentachlorophenol ²	Hot and cold ³	10.0	10	--	--	--	30	20	--	50	7 : 70 : --
2	do	do	Cold soaked	6.3	10	--	--	--	--	30	--	70	10 : 100 : 8.2
3	do	Fluor chrome	Hot and cold ³	.52 ⁴ (0.32)	10	--	--	--	--	50	--	50	10 : 100 : 12.3
		arsenate phenol											
		type A											
4	Sweetgum	Pentachlorophenol ²	do	15.1	10	--	--	--	--	30	--	70	10 : 100 : 7.4
5	do	Fluor chrome	do	.62 (.39)	10	--	--	--	--	60	--	40	10 : 100 : 8.5
		arsenate phenol											
		type A											
6	Tangle	Pentachlorophenol ²	do	9.4	10	--	--	--	--	60	--	40	10 : 100 : 6.8
7	do	Fluor chrome	do	.59 (.37)	10	--	--	--	--	100	--	--	10 : 100 : 10.4
		arsenate phenol											
		type A											
PLYWOOD TREATED AFTER GLUING													
8	Douglas-fir	Pentachlorophenol ²	Pressure	9.6	10	--	--	--	20	20	--	60	8 : 80 : --
9	do	do	Cold soaked	.9	10	--	--	--	--	20	10	70	10 : 100 : 5.3
10	do	do	do	1.4	10	--	--	--	--	--	20	80	10 : 100 : 7.1
11	do	Fluor chrome	Pressure	.61 (.38)	9	--	--	--	33	11	22	33	6 : 67 : --
		arsenate phenol											
		type A											
12	Sweetgum	Pentachlorophenol ²	do	10.6	10	--	--	--	--	70	--	30	10 : 100 : 6.3
13	do	Fluor chrome	do	.55 (.34)	10	--	--	--	--	50	10	40	10 : 100 : 7.6
		arsenate phenol											
		type A											
14	Tangle	Pentachlorophenol ²	do	10.4	10	--	--	--	10	70	--	20	9 : 90 : --
15	do	Fluor chrome	do	.60 (.37)	10	--	10	--	10	80	--	10	9 : 90 : --
		arsenate phenol											
		type A											
UNTREATED CONTROL													
16	Douglas-fir	--	--	--	10	--	--	--	--	--	--	100	10 : 100 : 3.6
17	Sweetgum	--	--	--	10	--	--	--	--	10	10	80	10 : 100 : 1.4
18	Tangle	--	--	--	10	--	--	--	--	40	--	60	10 : 100 : 1.9

¹In cooperation with the Bureau of Ships, Department of the Navy.

²Five percent solution conforming to MIL-W-18142 (SHIPS) specification 27 August 1954.

³Consisted of heating in a veneer dryer and immersion in unheated preservative solution until desired retention was obtained.

⁴Retention values in parentheses are based on preservative oxides.

⁵One stake by soft-rot fungus.

NOTE--The stakes were of 5-ply veneer, 5/8 x 4 x 18 in., and cut from panels 24 x 48 in. For item 10 the stakes were cut from the panels and then treated. For other treated items the stakes were cut after treatment and the edges exposed in sawing were brush coated with the preservative.

Table 34.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with copper formate, after about 20 years of service. Stakes placed in test at the Harrison Experimental Forest, Saucier, Miss., December 1956

[illegible]

Table 35.--Condition of southern pine stakes (2 x 4 in. and 3/4 x 3/4 in. nominal x 18 in.), treated with KP¹ preservative, after about 18-1/2 to 19 years of service. Stakes placed in test at Madison, Wis., May 1958, and on the Harrison Experimental Forest, Saucier, Miss., December 1957

Preservative	Loca- tion	Average retention	Num- ber	Condition of stakes November 1976								Total removed	Average life
				In Good test	Serviceable but showing some--	Destroyed by--							
				Decay	Termite	Decay	fungi	attack	fungi	Decay	and		
				attack	and	termite	attack	and	termite	attack			
		Pcf		Pct	Pct	Pct	Pct	Pct	Pct	Pct	Num- ber	Pct	Yr
STAKES 3/4 by 3/4 by 18 INCHES													
KP ¹ preservative	Miss.	0.09	29	--	--	--	56	11	33	9	100	9.5	
	Wis.	.18	28	--	--	--	38	50	--	12	5	62	--
	Miss.	.28	29	33	--	33	12	22	--	--	2	22	--
	Wis.	.37	10	70	--	10	--	20	--	--	2	20	--
Chromated zinc chloride	Wis.	1.20 ³ (0.73)	29	--	--	--	11	11	67	11	8	89	--
Coal-tar creosote	Wis.	11.6	10	20	--	40	20	10	--	10	2	20	--
Untreated controls	Wis.	--	10	--	--	--	40	--	60	10	100	2.1	
STAKES 2 BY 4 BY 18 INCHES													
KP ¹ preservative	Wis.	.09	10	--	--	--	20	50	--	30	8	80	--
	Wis.	.09	10	--	40	--	--	60	--	--	6	60	--
	Miss.	.19	10	10	10	10	40	30	--	--	3	30	--
	Wis.	.18	10	--	70	--	--	30	--	--	3	30	--
	Miss.	.27	10	60	--	10	10	20	--	--	2	20	--
	Wis.	.26	10	30	60	--	--	10	--	--	1	10	--
	Miss.	.37	10	80	--	--	--	20	--	--	2	20	--
	Wis.	.35	29	67	33	--	--	--	--	--	--	--	--
Chromated zinc chloride	Miss.	1.16 (.71)	10	--	--	20	30	--	--	50	5	50	--
	Wis.	1.21 (.74)	28	63	--	--	--	37	--	--	3	37	--
Coal-tar creosote	Miss.	10.2	10	30	20	10	40	--	--	--	--	--	--
	Wis.	10.2	10	50	50	--	--	--	--	--	--	--	--
Untreated controls	Miss.	--	10	--	--	--	20	--	80	10	100	2.5	
	Wis.	--	10	--	--	--	100	--	--	10	100	3.6	

¹Copper oxide and chlorophenols.

²Specimens found broken and eliminated from test.

³Retention values in parentheses are based on preservative oxides.

Table 17.--Condition of southern pine stakes (2 x 4 in. nominal and 3/4 x 3/4 in. x 18 in.) treated with fluor chrome arsenate phenol type A (AWP-1) and modified² after about 17 years of service. Stakes placed in test on the Harrison Experimental Forest, Lumbert, Miss., December 1959

Preservative	Average retention ¹	Num-ber	Condition of stakes November 1976							Total removed	Average life
			in : Good	Serviceable but showing some--	Destroyed by--						
			test :								
				Decay:Termite: Decay	fungi:attack : fungi						
				attack : and :							
				termite: :	termite:						
				attack :	attack :						
	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Num-ber	Pct	Yr

STAKES 2 BY 4 NOMINAL BY 18 INCHES

Fluor chrome arsenate	: 0.35 (0.22):	² 8	: --	: --	: --	: 63	: 38	: --	: --	: 3	: 38	: --
phenol (Federal Spec.)	: .50 (.31):	10	: --	: --	: --	: 50	: 40	: --	: 10	: 5	: 50	: --
TT-W-535 (Type A)	: .75 (.47):	10	: --	: --	: --	: 100	: --	: --	: --	: --	: --	: --
Fluor chrome arsenate	: .35 (.22):	² 4	: --	: --	: --	: 44	: 22	: 12	: 22	: 5	: 56	: --
phenol (Type A)	: .50 (.31):	10	: --	: --	: --	: 60	: 40	: --	: --	: 4	: 40	: --
(Modified) ³	: .76 (.47):	10	: --	: --	: --	: 80	: 20	: --	: --	: 2	: 20	: --
Untreated controls	: --	: 10	: --	: --	: --	: --	: 40	: 20	: 40	: 10	: 100	: 2.1

STAKES 3/4 BY 3/4 BY 18 INCHES

Fluor chrome arsenate	: .36 (.22):	² 9	: --	: --	: --	: --	: 34	: 33	: 33	: 9	: 100	: 6.7
phenol (Federal Spec.)	: .51 (.32):	10	: --	: --	: --	: 10	: 50	: 30	: 10	: 9	: 90	: --
TT-W-535 (Type A)	: .77 (.48):	² 8	: --	: --	: --	: 37	: 13	: 13	: 37	: 5	: 63	: --
Fluor chrome arsenate	: .37 (.23):	10	: --	: --	: --	: --	: 20	: 30	: 50	: 10	: 100	: 8.2
phenol (Type A)	: .52 (.32):	10	: --	: --	: --	: --	: 20	: 40	: 40	: 10	: 100	: 11.6
(Modified) ³	: .80 (.38):	² 9	: --	: --	: --	: 44	: 34	: 11	: 11	: 5	: 56	: --
Untreated controls	: --	: 10	: --	: --	: --	: --	: 30	: 20	: 50	: 10	: 100	: 1.4

¹Retention values in parentheses are based on preservative oxides.

²Stakes damaged mechanically and eliminated from test.

³Sodium pentachlorophenate substituted for dinitrophenol.

Table 39.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with blends of extracts from Texas lignite tar, after about 16 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., December 1960

Lignite-tar extracts	Condition of stakes December 1976															Total removed	Average life
	Average retention	Number in test	Good	Serviceable but showing some--	Destroyed by--	Decay:Termite: Decay: fungi: attack: and : termite: attack											
	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Num-ber	Pct	Yr	
Hexane-soluble residue, 25 pct; and hexane distillate, 75 pct (by weight)	5.1	10	--	--	40	20	--	40	6	60	--	--	--	--	--	--	
	10.0	10	30	10	---	60	--	--	--	--	--	--	--	--	--	--	
	14.1	10	70	10	--	20	--	--	--	--	--	--	--	--	--	--	
High-boiling methanol solubles, 25 pct; and hexane distillate, 75 pct (by weight)	5.0	10	--	--	70	--	--	30	3	30	--	--	--	--	--	--	
	9.3	10	20	10	--	70	--	--	--	--	--	--	--	--	--	--	
	15.2	10	80	--	--	20	--	--	--	--	--	--	--	--	--	--	
High-boiling methanol solubles, 10 pct; hexane-soluble residue, 20 pct; and hexane distillate, 70 pct (by weight)	5.1	10	--	--	80	10	--	10	2	20	--	--	--	--	--	--	
	10.1	10	10	--	90	--	--	--	--	--	--	--	--	--	--	--	
	14.7	10	70	10	--	20	--	--	--	--	--	--	--	--	--	--	
High-boiling methanol solubles, 20 pct; hexane-solution residue, 10 pct; and hexane distillate, 70 pct (by weight)	5.2	10	--	--	60	20	--	20	4	40	--	--	--	--	--	--	
	10.0	10	--	--	10	90	--	--	--	--	--	--	--	--	--	--	
	15.2	10	70	10	10	10	--	--	--	--	--	--	--	--	--	--	
High-boiling methanol solubles, 15 pct; and hexane distillate, 85 pct (by weight)	5.0	10	--	--	80	10	10	--	2	20	--	--	--	--	--	--	
	10.2	10	20	10	--	70	--	--	--	--	--	--	--	--	--	--	
	14.9	10	70	10	--	20	--	--	--	--	--	--	--	--	--	--	
High-boiling methanol solubles, 24.5 pct; hexane distillate, 74.5 pct, and petroleum sulfonate (Morpel X-914), 1 pct (by weight)	5.1	10	--	--	70	20	--	10	3	30	--	--	--	--	--	--	
	9.9	10	30	--	70	--	--	--	--	--	--	--	--	--	--	--	
	15.0	10	80	--	20	--	--	--	--	--	--	--	--	--	--	--	
Untreated controls	--	10	--	--	--	--	--	--	100	10	100	2.6					

Table 40.--Condition of 1 x 4 x 18 in. stakes of embedded fiberboard¹ and untreated Douglas-fir heartwood after 16 years of service. Stakes placed in test at the Harrison Experimental Forest, Saucier, Miss., December 1960

Material	: Number:	Condition of stakes November 1976	Total removed	Average life
:	:	:	:	:
:	in :	:	:	:
:	test :	Good: Serviceable but : Destroyed by--	:	:
:	:	: showing some-- :	:	:
:	:	:	:	:
:	:	: Decay:Termite: Decay :	:	:
:	:	: Decay:Termite: Decay :fungi:attack : fungi :	:	:
:	:	: attack : and : and :	:	:
:	:	: termite: : termite: :	:	:
:	:	: attack : attack :	:	:
:	:	: : : :	:	:
:	:	:	:	:
:	Pct.:Pct.	Pct. Pct. Pct. Pct. Pct.	Number: Pct.:	Yr.
Embedded fiberboard ¹	29 : -- : 11 : : : : 389 : -- : -- : 8 : 89 :			.
Douglas-fir heartwood	10 : -- : -- : : : : 70 : 10 : 20 : 10 : 100 : 3.0 :			

1-Western hemlock strands in portland cement.

2 $\frac{2}{3}$ Stake missing and eliminated from test.

3-Stake missing and eliminated from test.
-Failures attributed mainly to the effect of moisture.

Table 41.--Condition of southern pine stakes (2 x 4 in. nominal x 16 in.) treated with tributyltin oxide and pentachlorophenol solutions with heavy and light petroleum solvents and with and without the addition of Dieldrin and Aldrin, after about 16 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., December 1960

Preservative	Average retention	Number in test	Condition of stakes December 1976								Total removed	Average life
			Good	Serviceable but showing some--	Destroyed by--	Decay	Termite	Decay	fungi	attack	fungi	
						and	termite					
						attack		attack				
	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Num-ber	Pct	Yr	
SOLUTIONS WITH STODDARD SOLVENT												
Tributyltin oxide, 0.3 pct; and Dieldrin, 0.3 pct	8.0	10	--	--	--	90	--	10	10	100	4.9	
Tributyltin oxide, 0.6 pct; and Dieldrin, 0.3 pct	8.0	10	--	--	--	90	--	10	10	100	6.9	
Tributyltin oxide, 0.3 pct; and Aldrin, 0.3 pct	8.0	10	--	--	--	90	--	10	10	100	4.6	
Tributyltin oxide 0.3 pct	8.2	10	--	--	--	80	--	20	10	100	4.5	
0.6 pct	7.9	10	--	--	--	50	--	50	10	100	7.0	
Tributyltin oxide, 0.3 pct; Dieldrin, 0.3 pct; and water repellent, 4.7 pct	8.0	10	--	--	--	100	--	--	10	100	6.9	
Tributyltin oxide, 0.3 pct; Aldrin, 0.3 pct; and water repellent, 4.7 pct	8.0	10	--	--	--	70	--	30	10	100	5.3	
Dieldrin, 0.6 pct	8.0	10	--	--	--	90	--	10	10	100	4.0	
Pentachlorophenol, 5 pct; pine oil, 5 pct; and water repellent, 4.7 pct	8.0	10	--	--	--	100	--	--	--	--	--	
Pentachlorophenol, 5 pct; pine oil, 5 pct; Dieldrin, 0.3 pct; and water repellent, 4.7 pct	8.0	10	--	--	--	100	--	--	--	--	--	
Water repellent, 4.7 pct	8.0	10	--	--	--	80	--	20	10	100	4.3	
Pentachlorophenol, 5 pct; pine oil, 5 pct; Dieldrin, 0.3 pct; stabilizer wax, 2 pct; and water repellent, 4.7 pct	8.0	10	--	--	--	100	--	--	--	--	--	
SOLUTIONS WITH HEAVY PETROLEUM SOLVENT (AWPA P9)												
Tributyltin oxide, 0.3 pct; and Dieldrin, 0.3 pct	8.0	10	--	--	--	90	10	--	1	10	--	
Tributyltin oxide, 0.6 pct; and Dieldrin, 0.3 pct	8.0	10	--	--	--	100	--	--	--	--	--	
Tributyltin oxide 0.3 pct	8.0	10	--	--	--	90	10	--	1	10	--	
0.6 pct	8.0	10	--	--	--	100	--	--	--	--	--	
Pentachlorophenol, 5 pct	8.0	10	10	10	--	80	--	--	--	--	--	
Pentachlorophenol, 5 pct; and stabilizer wax, 2 pct	7.7	10	10	20	--	70	--	--	--	--	--	
Petroleum solvent controls	8.0	10	--	--	--	80	--	--	20	2	20	--
UNTREATED CONTROLS												
None	--	10	--	--	--	70	--	30	10	100	3.1	

Table 42.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in. and 3/4 x 3/4 in. x 12 in.) treated with pentachlorophenol in liquefied petroleum gas and in heavy and light petroleum solvents, after about 15-17 years of service. Stakes installed at Valley View Test Plot, Madison Wis., and on Harrison Experimental Forest, Sauvier, Miss., during July 1961.

Preservative	Location	Average retention		Number	Condition of stakes December 1976								Total	Average
		By weight	By analysis	in test	Good	Serviceable but showing some	Destroyed over-					removed	life	
		Solu- tion	Penta- chloro- phenol	sis, penta- chloro- phenol		Decay: attack	Termite and	Decay: fungi	Termite attack	Decay: fungi	Termite and			
		Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Sum- ber	Pct	Yr
STAKES 2 BY 4 (JOMINAL) BY 18 LICHES														
Pentachlorophenol in liquefied petroleum gas ¹	:Miss.: -- : -- :	$\frac{2}{5}$.14 :	10 :	-- : -- : -- :	80 :	-- : -- :	20 :	2 :	20 :	-- :				
	:	-- : -- :	$\frac{5}{19}$.19 :	10 :	-- : -- : -- :	40 :	10 :	-- :	50 :	6 :	60 :	-- :		
	:	-- : -- :	$\frac{5}{34}$.34 :	10 :	-- : -- : -- :	100 :	-- : -- :	-- :	-- :	-- :	-- :	-- :		
	:	-- : -- :	$\frac{5}{58}$.58 :	10 :	-- : -- : -- :	100 :	-- : -- :	-- :	-- :	-- :	-- :	-- :		
Solutions with AWPA-P9 (heavy petroleum solvent)	:													
Pentachlorophenol	:													
3.5 pct (by weight)	:	3.0 :	0.11 :	.14 : 10 :	-- : -- : -- :	100 :	-- : -- :	-- :	-- :	-- :	-- :	-- :		
	:	4.5 :	.19 :	.22 : 10 :	-- : -- : -- :	100 :	-- : -- :	-- :	-- :	-- :	-- :	-- :		
4.2 pct (by weight)	:	6.8 :	.29 :	.32 : 10 :	10 :	10 :	80 :	-- : -- :	-- :	-- :	-- :	-- :		
	:	16.0 :	.67 :	.69 : 10 :	100 :	-- : -- :	-- :	-- :	-- :	-- :	-- :	-- :		
Solutions with Stoddard solvent:	:													
Pentachlorophenol, 4.0 pct; paraffin, 2 pct; and Pentalyn-H, 10 pct (by weight)	:	3.6 :	.14 :	.14 : 10 :	-- : -- : -- :	10 :	10 :	-- :	80 :	9 :	90 :	-- :		
	:	4.6 :	.18 :	.18 : 10 :	-- : -- : -- :	50 :	-- :	-- :	50 :	5 :	50 :	-- :		
Pentachlorophenol, 5 pct; paraffin, 2 pct and Pentalyn-H, 10 pct (by weight)	:	7.6 :	.38 :	.39 : 10 :	-- : -- : -- :	100 :	-- :	-- :	-- :	-- :	-- :	-- :		
	:	13.5 :	.67 :	.70 : 10 :	40 :	-- :	60 :	-- :	-- :	-- :	-- :	-- :		
Untreated controls	:	-- :	-- :	-- : 10 :	-- : -- : -- :	-- :	30 :	30 :	40 :	10 :	100 :	2.1		
STAKES 3/4 BY 3/4 BY 17 INCHES														
Pentachlorophenol in liquefied petroleum gas ¹	:Miss.: -- : -- :	$\frac{3}{15}$.15 :	10 :	-- : -- : -- :	-- : 40 :	-- : -- :	60 :	10 :	100 :	5.5				
	:Wis.: -- : -- :	$\frac{3}{15}$.15 :	15 :	-- : -- : -- :	-- : 100 :	-- : -- :	-- : 15 :	100 :	10.0					
	:Miss.: -- : -- :	$\frac{3}{19}$.19 :	$\frac{4}{8}$.5 :	-- : -- : -- :	-- : 50 :	-- : -- :	50 :	8 :	100 :	4.6				
	:Wis.: -- : -- :	$\frac{3}{19}$.19 :	$\frac{4}{14}$.29 :	-- : -- : -- :	-- : 100 :	-- : -- :	-- : 14 :	100 :	12.4					
	:Miss.: -- : -- :	$\frac{3}{31}$.31 :	$\frac{5}{9}$.56 :	-- : -- : -- :	23 : 22 :	11 :	44 :	7 :	77 :	-- :				
	:Wis.: -- : -- :	$\frac{3}{31}$.31 :	$\frac{4}{14}$.29 :	-- : 21 :	-- : 79 :	-- :	-- : 11 :	79 :	-- :					
	:Miss.: -- : -- :	$\frac{3}{48}$.48 :	$\frac{4}{8}$.5 :	-- : -- : -- :	38 : 25 :	12 :	25 : 5 :	62 :	-- :					
	:Wis.: -- : -- :	$\frac{3}{48}$.48 :	$\frac{4}{14}$.29 :	-- : 79 :	-- : 21 :	-- :	-- : 3 :	21 :	-- :					
Solutions with AWPA-P9 (heavy petroleum solvent)	:Miss.: 3.2 :	.13 :	-- : $\frac{4}{9}$.44 :	-- : -- : -- :	22 : 11 :	-- :	68 :	7 :	78 :	-- :				
	:Wis.: 3.3 :	.14 :	-- : $\frac{4}{11}$.36 :	-- : 82 :	-- :	18 :	-- : 2 :	18 :	-- :					
Pentachlorophenol, 4.2 pct (by weight)	:Miss.: 3.8 :	.16 :	-- : $\frac{4}{10}$.4 :	-- : 10 :	10 :	10 :	70 :	9 :	79 :	-- :				
	:Wis.: 3.9 :	.16 :	-- : $\frac{4}{10}$.4 :	-- : 70 :	-- :	30 :	-- : 3 :	30 :	-- :					
	:Miss.: 5.7 :	.24 :	-- : $\frac{4}{44}$.09 :	-- : 75 :	-- :	25 :	1 :	25 :	-- :					
	:Wis.: 5.5 :	.23 :	-- : $\frac{4}{41}$.09 :	-- : 73 :	-- :	27 :	-- : 3 :	27 :	-- :					
	:Miss.: 16.7 :	.70 :	-- : $\frac{4}{10}$.4 :	90 : 10 :	-- : -- :	-- :	-- : -- :	-- :	-- :					
	:Wis.: 17.2 :	.72 :	-- : $\frac{4}{14}$.29 :	43 : 57 :	-- : -- :	-- :	-- : -- :	-- :	-- :					
Solutions in Stoddard solvent	:Miss.: 3.5 :	.14 :	-- : $\frac{4}{9}$.44 :	-- : -- : -- :	-- : 45 :	10 :	45 :	9 :	100 :	5.6				
Pentachlorophenol, 4.0 pct; paraffin, 2 pct; and Pentalyn-H, 10 pct (by weight)	:Wis.: 3.0 :	.12 :	-- : $\frac{4}{11}$.36 :	-- : 9 :	-- : 91 :	-- :	-- : 10 :	91 :	-- :					
	:Miss.: 3.9 :	.16 :	-- : 10 :	-- : -- : -- :	-- : 30 :	-- :	70 : 10 :	100 :	4.9					
	:Wis.: 4.0 :	.16 :	-- : $\frac{4}{13}$.31 :	-- : -- : -- :	-- : 100 :	-- :	-- : 13 :	100 :	10.8					
Pentachlorophenol, 5.0 pct; paraffin, 2.0 pct; and Pentalyn-H, 10 pct (by weight)	:Miss.: 6.4 :	.32 :	-- : $\frac{4}{9}$.44 :	-- : -- : -- :	33 : 11 :	-- :	56 :	6 :	67 :	-- :				
	:Wis.: 6.6 :	.33 :	-- : $\frac{4}{5}$.8 :	-- : 20 :	-- : 80 :	-- :	-- : 12 :	80 :	-- :					
	:Miss.: 14.4 :	.72 :	-- : $\frac{4}{9}$.44 :	11 : -- :	-- : 89 :	-- :	-- : -- :	-- :	-- :					
	:Wis.: 14.6 :	.73 :	-- : $\frac{4}{13}$.31 :	23 : 69 :	-- : -- :	8 :	-- : 1 :	8 :	-- :					
Untreated controls	:Miss.: -- : -- :	-- : -- : 10 :	-- : -- : -- :	-- : -- : -- :	-- : 40 :	30 :	30 : 10 :	100 :	1.5					
	:Wis.: -- : -- :	-- : -- : 15 :	-- : -- : -- :	-- : -- : -- :	-- : 100 :	-- : 13 :	100 :	4.4						

¹It has been reported that the formulation of treating solution in liquefied petroleum gas has been changed since the stakes were treated.

²From analysis of composite sample of cross-section waters taken at midpoint from 10 24 x 48-in. stakes and batched to the 10 stakes treated for installation. Since retentions were not determined for individual test stakes, extra stakes were not treated to provide a selection, according to retentions, for the test installation.

⁵Based on analysis by Bell Telephone Laboratories of 2-in. sections cut adjacent to test stakes.^aStakes injured mechanically and eliminated from test.

Table 44.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with heptadecyltrimethyltetrahydropyrimidine (HTP) in No. 2 fuel oil, after about 13 years of service. Stakes placed in test at the Harrison Experimental Forest, Sauer, Miss., December 1963

Preservative	Average retention	Num-ber	Condition of stakes November 1976						Total removed	Aver-age life
			Good	Serviceable but showing some--	Destroyed by--					
	Solu-tion	HTP test								

Table 45.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in. and 3/4 x 3/4 x 16 in.) treated with pentachlorophenol in liquefied petroleum gas and in heavy petroleum solvent, after about 13 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., December 1963

Preservative	Average retention	Number	Condition of stakes December 1976										Total removed	Average life
			in Good	Serviceable but showing some--	Destroyed by--									
Solu- tion	Penta- chloro-	test				Decay	Termite	Decay	fungi	attack	fungi			
	phenol			attack	and		termite		and		termite			
				attack			attack				attack			
	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Num- ber	Pct	Yr	
STAKES 2 BY 4 INCHES														
Pentachlorophenol	--	1.34	10	--	--	80	10	--	10	2	20	--	--	--
in liquefied		1.49	10	--	--	100	--	--	--	--	--	--	--	--
petroleum gas ²		1.65	10	--	--	100	--	--	--	--	--	--	--	--
		1.39	10	--	--	100	--	--	--	--	--	--	--	--
Pentachlorophenol	10.6	4.53	10	80	20	--	--	--	--	--	--	--	--	--
5 pct in heavy														
petroleum oil														
Heavy petroleum oil	8.0	--	10	--	--	10	80	--	--	10	1	10	--	--
Untreated controls	--	--	10	--	--	--	20	--	80	10	100	2.5		
STAKES 3/4 BY 3/4 INCH														
Pentachlorophenol	--	1.34	10	--	--	10	60	--	30	9	90	--	--	--
in liquefied		1.40	5 ³	--	--	12	76	--	12	7	88	--	--	--
petroleum gas ²		1.59	5 ³	--	--	38	38	--	24	5	62	--	--	--
		1.70	5 ³	--	--	11	78	11	11	2	22	--	--	--
Pentachlorophenol	10.8	4.54	5 ³	38	--	50	12	--	--	--	--	--	--	--
5 pct in heavy														
petroleum oil														
Heavy petroleum oil	8.3	--	5 ³	--	--	--	75	25	--	8	100	6.6		
Untreated controls	--	--	10	--	--	--	50	10	40	10	100	1.4		

¹By x-ray analysis of samples from pieces from which stakes were cut.

²With cosolvent of isopropyl ether.

³Treated in commercial charge with poles and crossarms.

⁴Computed.

⁵Stake mechanically damaged and eliminated from test.

Table 47. Condition of southern pine stakes (2 x 4 in. nominal x 18 inch treated with 14 standard wood preservatives after about 9 years of service. Stakes placed in test in November 1967 at Lake Charles, La., in an area infested by Formosan termites, and on the Harrison Experimental Forest, Nacole, Miss. --- continued

Preservative	AWPA classification	Average retention	Number in test	Condition of stakes December 1976				Total removed	Average life
				Good	Serviceable but showing some--	Destroyed by--			
		Pct		Pct	Pct	Pct	Pct	Number	Yr
Chromated copper arsenate--type A:									
	PS-68 :La.	.40 (0.23)	10	70	10	20	--	--	--
		.76 (.44)	10	80	20	--	--	--	--
		1.11 (.64)	10	100	--	--	--	--	--
Chromated copper arsenate--type B:									
	Miss.	.39 (.22)	10	100	--	--	--	--	--
		.76 (.44)	10	100	--	--	--	--	--
		1.14 (.66)	19	100	--	--	--	--	--
Chromated zinc chloride									
	PS-68 :La.	.25 (.23)	10	90	10	--	--	--	--
		.44 (.40)	10	100	--	--	--	--	--
		.65 (.59)	10	100	--	--	--	--	--
	Miss.	.25 (.23)	10	100	--	--	--	--	--
		.42 (.38)	10	100	--	--	--	--	--
		.61 (.55)	10	100	--	--	--	--	--
Fluor chrome arsenate phenol--type A									
	PS-68 :La.	.76 (.46)	10	--	--	--	80	20	10; 100
		1.02 (.62)	10	--	--	--	10	60	10; 100
		1.50 (.92)	10	--	--	--	20	10	8; 80
	Miss.	.76 (.46)	10	30	20	20	10	20	3; 30
		1.02 (.62)	10	10	40	20	30	--	3; 30
		1.57 (.96)	10	60	10	20	10	--	1; 10
Fluor chrome arsenate phenol--type B									
	PS-68 :La.	.35 (.22)	10	20	10	--	20	10	3; 30
		.50 (.31)	10	--	20	10	40	20	3; 30
		1.11 (.69)	10	30	20	30	--	--	--
	Miss.	.35 (.22)	10	40	10	50	--	--	--
		.51 (.31)	10	50	20	10	--	--	--
		1.16 (.72)	10	100	--	--	--	--	--
Untreated controls:									
	PS-68 :La.	.35 (.21)	10	--	--	--	70	30	3; 30
		.50 (.30)	10	50	--	10	40	--	--
		1.12 (.68)	10	60	10	--	30	--	--
	Miss.	.35 (.21)	10	50	10	20	10	--	1; 10
		.51 (.30)	10	90	--	10	--	--	--
		1.19 (.72)	10	100	--	--	--	--	--
	La.	--	10	--	--	--	10	90	10; 100
	Miss.	--	10	--	--	--	30	20	10; 100

¹ Stake damaged by falling tree eliminated from test.

² Retention values in parentheses are based on preservative oxides.

Table 48. --Condition of southern pine stakes (2 x 4 in. nominal x 18 in.) treated with copper-chrome-phosphorus and chromated copper arsenate Type III preservatives, after about 5 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., December 1971, and Madison, Wis., May 1972

Preservative	Location	Average retention	Number in test	Condition of stakes	December 1976	Total removed	Average life
				Serviceable but showing some--	Destroyed by--		
				Decay:Termite: Decay: fungi: attack: and	Decay:Termite: Decay: fungi: attack: and		
				attack: and termite: attack:	termite: attack:		
		Pct	Pct	Pct	Pct	Num-ber	Yr
Copper-chrome-phosphorus	Miss.	1.0.26	10 : 30	20 : 10	40 : 40	4 : 40	--
	Wis.	1.27	10 : 60	30 : --	10 : --	1 : 10	--
	Miss.	1.46	10 : 60	10 : --	20 : --	2 : 20	--
	....do....	1.75	10 : 80	10 : --	-- : --	-- : --	--
	Wis.	1.74	10 : 60	40 : --	-- : --	-- : --	--
	Miss.	1.50	10 : 80	10 : --	-- : --	-- : --	--
Chromated copper arsenate: Type III (Fed. Spec. TT-W-550)	....do....	2.20	10 : 100	-- : --	-- : --	-- : --	--
	Wis.	2.20	10 : 100	-- : --	-- : --	-- : --	--
	Miss.	2.40	10 : 100	-- : --	-- : --	-- : --	--
	Wis.	2.40	10 : 90	10 : --	-- : --	-- : --	--
	Miss.	2.60	10 : 100	-- : --	-- : --	-- : --	--
	Wis.	2.60	10 : 90	10 : --	-- : --	-- : --	--
Untreated controls	Miss.	--	-- : --	-- : --	10 : 90	10 : 100	2.9
	Wis.	--	10 : 20	40 : --	-- : --	4 : 40	--

¹ Retention based on Osmose Company's analysis of preservative oxides.

² Retention based on preservative oxides.

Stakes placed in test at Madison, Wis., May 1976, and on the Harrison Experimental Forest, Saucier, Miss., Dec. 1975

SOUTHERN PINE^{1,2} 2- BY 4-INCH NOMINAL BY 18-INCH UNINCISED

SOUTHERN PINE^{1,2} 2- BY 4-INCH NOMINAL BY 18-INCH INCISED

SOUTHERN PINE¹ 3/4- BY 3-1/2- BY 18-INCH PLYWOOD

Chromated copper												
Arsenate type III ⁴												
	Miss.	$\frac{5}{5}$.36	: 10	: 100:	--	:	--	:	--	:	--	:
	Wis.	$\frac{5}{5}$.36	: 10	: --:	--	:	--	:	--	:	--	:
	Miss.	$\frac{5}{5}$.74	: 10	: 100:	--	:	--	:	--	:	--	:
	Wis.	$\frac{5}{5}$.74	: 10	: --:	--	:	--	:	--	:	--	:
	Miss.	$\frac{5}{5}$ 1.62	: 10	: 100:	--	:	--	:	--	:	--	:
	Wis.	$\frac{5}{5}$ 1.62	: 10	: --:	--	:	--	:	--	:	--	:
Do ⁶												
	Miss.	$\frac{5}{5}$.36	: 10	: 100:	--	:	--	:	--	:	--	:
	Wis.	$\frac{5}{5}$.36	: 10	: --:	--	:	--	:	--	:	--	:
	Miss.	$\frac{5}{5}$.74	: 10	: 100:	--	:	--	:	--	:	--	:
	Wis.	$\frac{5}{5}$.74	: 10	: --:	--	:	--	:	--	:	--	:
	Miss.	$\frac{5}{5}$ 1.62	: 10	: 100:	--	:	--	:	--	:	--	:
	Wis.	$\frac{5}{5}$ 1.62	: 10	: --:	--	:	--	:	--	:	--	:

Table 51.--Condition of southern pine, Douglas-fir and Engelmann spruce heartwood stakes, treated with ammoniacal copper arsenate and chromated copper arsenate, after about 1 year of service. Stakes placed in test at Madison, Wis., May 1976, and on the Harrison Experimental Forest, Saucier, Miss., Dec. 1975--continued

Preservative	Loca- tion	Average reten-	Number in	Condition of stakes December 1976						Total removed	Average life
				Good	Serviceable but showing some--	Destroyed by--	Decay	Termite	Decay		
			test				fungi	attack	fungi		
				Decay	Termite	Decay	fungi	attack	fungi		
				attack	and				and		
					termite				termite		
					attack				attack		
		Pct		Pct	Pct	Pct	Pct	Pct	Pct	Number	Pct
											Yr

SOUTHERN PINE^{1,2} 2- BY 4-INCH NOMINAL BY 18-INCH UNINCISED

Ammoniacal copper
arsenate

:Miss.	: 0.11	: 10	: 100:	--	--	--	--	--	--	--	--
:Wis.	: .07	: 10	: --:	--	--	--	--	--	--	--	--
:Miss.	: .30	: 10	: 100:	--	--	--	--	--	--	--	--
:Wis.	: .16	: 10	: --:	--	--	--	--	--	--	--	--
:Miss.	: .42	: 10	: 100:	--	--	--	--	--	--	--	--
:Wis.	: .26	: 10	: --:	--	--	--	--	--	--	--	--

SOUTHERN PINE^{1,2} 2- BY 4-INCH NOMINAL BY 18-INCH INCISED

Do.....	:Miss.	: .14	: 10	: 100:	--	--	--	--	--	--	--
	:Wis.	: .07	: 10	: --:	--	--	--	--	--	--	--
	:Miss.	: .30	: 10	: 100:	--	--	--	--	--	--	--
	:Wis.	: .15	: 10	: --:	--	--	--	--	--	--	--
	:Miss.	: .65	: 10	: 100:	--	--	--	--	--	--	--
	:Wis.	: .39	: 10	: --:	--	--	--	--	--	--	--

SOUTHERN PINE¹ 3/4- BY 3-1/2- BY 18-INCH PLYWOOD

Do ³	:Miss.	: .39	: 10	: 100:	--	--	--	--	--	--	--
	:Wis.	: .38	: 10	: --:	--	--	--	--	--	--	--
	:Miss.	: .80	: 10	: 100:	--	--	--	--	--	--	--
	:Wis.	: .79	: 10	: --:	--	--	--	--	--	--	--
	:Miss.	: 1.19	: 10	: 100:	--	--	--	--	--	--	--
	:Wis.	: 1.15	: 10	: --:	--	--	--	--	--	--	--

Do ⁴	:Miss.	: $\frac{5}{5}$.38	: 10	: 100:	--	--	--	--	--	--	--
	:Wis.	: $\frac{5}{5}$.38	: 10	: --:	--	--	--	--	--	--	--
	:Miss.	: $\frac{5}{5}$.77	: 10	: 100:	--	--	--	--	--	--	--
	:Wis.	: $\frac{5}{5}$.77	: 10	: --:	--	--	--	--	--	--	--
	:Miss.	: $\frac{5}{5}$ 1.08	: 10	: 100:	--	--	--	--	--	--	--
	:Wis.	: $\frac{5}{5}$ 1.08	: 10	: --:	--	--	--	--	--	--	--

Do ⁶	:Miss.	: $\frac{5}{5}$.38	: 10	: 100:	--	--	--	--	--	--	--
	:Wis.	: $\frac{5}{5}$.38	: 10	: --:	--	--	--	--	--	--	--
	:Miss.	: $\frac{5}{5}$.77	: 10	: 100:	--	--	--	--	--	--	--
	:Wis.	: $\frac{5}{5}$.77	: 10	: --:	--	--	--	--	--	--	--
	:Miss.	: $\frac{5}{5}$ 1.08	: 10	: 100:	--	--	--	--	--	--	--
	:Wis.	: $\frac{5}{5}$ 1.08	: 10	: --:	--	--	--	--	--	--	--

(Page 2 of 6)

Stakes placed in test at Madison, Wis., May 1976, and on the Harrison Experimental Forest, Saucier, Miss., Dec. 1975--continued

DOUGLAS-FIR 2- BY 4-INCH NOMINAL BY 18-INCH UNINCISEDDOUGLAS-FIR 2- BY 4-INCH NOMINAL BY 18-INCH INCISED

DOUGLAS-FIR 3/4- BY 3-1/2- BY 18-INCH PLYWOOD

[illegible]

Stakes placed in test at Madison, Wis., May 1976, and on the Harrison Experimental Forest, Saucier, Miss., Dec. 1975--continued

DOUGLAS-FIR 2- BY 4-INCH NOMINAL BY 18-INCH UNINCISED

:Miss.: 0.70	:	10	:	100:	-- :	-- :	-- :	-- :	-- :	-- :	-- :
:Wis.: .61	:	10	:	--:	-- :	-- :	-- :	-- :	-- :	-- :	-- :
:Miss.: 1.42	:	10	:	100:	-- :	-- :	-- :	-- :	-- :	-- :	-- :
:Wis.: 1.29	:	10	:	--:	-- :	-- :	-- :	-- :	-- :	-- :	-- :
:Miss.: 2.14	:	10	:	100:	-- :	-- :	-- :	-- :	-- :	-- :	-- :
:Wis.: 1.95	:	10	:	--:	-- :	-- :	-- :	-- :	-- :	-- :	-- :

Do.....	:Miss.	: .70	:	10	:	100:	-- :	-- :	-- :	-- :	-- :	-- :	-- :
	:Wis.	: .62	:	10	:	--:	-- :	-- :	-- :	-- :	-- :	-- :	-- :
	:Miss.	: 1.41	:	10	:	100:	-- :	-- :	-- :	-- :	-- :	-- :	-- :
	:Wis.	: 1.26	:	10	:	--:	-- :	-- :	-- :	-- :	-- :	-- :	-- :
	:Miss.	: 2.17	:	10	:	100:	-- :	-- :	-- :	-- :	-- :	-- :	-- :
	:Wis.	: 2.00	:	10	:	--:	-- :	-- :	-- :	-- :	-- :	-- :	-- :

[illegible][illegible][illegible]

Forest, Saucier, Miss., Dec. 1975--continued

ENGELMANN SPRUCE 2- BY 4-INCH NOMINAL BY 18-INCH UNINCISED

ENGELMANN SPRUCE 2- BY 4-INCH NOMINAL BY 18-INCH INCISED

ENGELMANN SPRUCE 3/4- BY 3-1/2- BY 18-INCH PLYWOOD

[illegible]

Table 51.--Condition of southern pine, Douglas-fir and Engelmann spruce heartwood stakes, treated with ammoniacal copper arsenate and chromated copper arsenate, after about 1 year of service. Stakes placed in test at Madison, Wis., May 1976, and on the Harrison Experimental Forest, Saucler, Miss., Dec. 1975--continued

[illegible]

ENGELMANN SPRUCE 2- BY 4-INCH NOMINAL BY 18-INCH UNINCISED

Ammoniacal copper
arsenate

:Miss.	: .06	: 10	: 100:	-- :	-- :	-- :	-- :	-- :	-- :	-- :
:Wis.	: .20	: 10	:	-- :	-- :	-- :	-- :	-- :	-- :	-- :
:Miss.	: .63	: 10	: 100:	-- :	-- :	-- :	-- :	-- :	-- :	-- :
:Wis.	: .50	: 10	:	-- :	-- :	-- :	-- :	-- :	-- :	-- :
:Miss.	: 1.03	: 10	: 100:	-- :	-- :	-- :	-- :	-- :	-- :	-- :
:Wis.	: .75	: 10	:	-- :	-- :	-- :	-- :	-- :	-- :	-- :

ENGELMANN SPRUCE 2- BY 4-INCH NOMINAL BY 18-INCH INCISED

[illegible]

ENGELMANN SPRUCE 3/4- BY 3-1/2- BY 18-INCH PLYWOOD

[illegible]

¹Some southern pine contained a small amount of sapwood, and the southern pine plywood was mixed heartwood and sap.

²Resin content of the southern pine ranged from 0.87 to 27.4 percent.

³Treated as 3/4- x 3-1/2- x 18- inch stakes.

⁴~~Stakes~~ cut from treated 2- x 4- foot panel.

⁵Retention-by-weight of panels from which stakes were cut.

⁶Stakes cut from treated 2- x 4- foot panel, all cut surfaces given a liberal brush coat of a 4.5 percent solution of the preservative the panels were treated with.

Table 52.---Condition of southern pine stakes (2 x 4 in. nominal x 18 in.) stakes, treated with ammoniacal copper borate and ammoniacal copper arsenate, after about 1 year of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., December 1975

Preservative	Average ¹ retention	Number in test	Condition of stakes December 1976										Total removed	Average life
			Good	Serviceable but showing some--	Decay:Termite: Decay: fungi: attack	and	and	termite: attack	Decay:Termite: Decay: fungi: attack	and	and	termite: attack		
	Pcf		Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Number	Yr
Ammoniacal copper borate	1.33	35	100	--	--	--	--	--	--	--	--	--	--	--
	.655	35	100	--	--	--	--	--	--	--	--	--	--	--
	.455	35	100	--	--	--	--	--	--	--	--	--	--	--
	.323	35	100	--	--	--	--	--	--	--	--	--	--	--
	.225	35	100	--	--	--	--	--	--	--	--	--	--	--
	.165	35	97	--	--	3	--	--	--	--	--	1	3	--
Ammoniacal copper arsenate	1.35	35	100	--	--	--	--	--	--	--	--	--	--	--
	.655	35	100	--	--	--	--	--	--	--	--	--	--	--
	.469	35	100	--	--	--	--	--	--	--	--	--	--	--
	.330	35	100	--	--	--	--	--	--	--	--	--	--	--
	.226	35	100	--	--	--	--	--	--	--	--	--	--	--
	.165	35	97	--	--	3	--	--	--	--	--	--	--	--
Untreated controls	--	20	10	--	40	45	5	--	--	--	--	1	5	--

¹Retention based on preservative oxides.

Table 53.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with fire retardant chemicals, after about 6 months service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., May 1976

Preservative	Average retention	Number in test	Condition of stakes December 1976				Total removed	Average life
			Good	Serviceable but showing some--	Destroyed by--			
					Decay:Termite: Decay			
					attack: and : fungi			
					: termite: : and			
					: attack: : termite:			
					: : : attack:			
	Pcf		Pct: Pct:	Pct: Pct:	Pct: Pct:	Number: Pct:		Yr
UDFP ¹ fire retardant	2.8	10	70: --	30 : --	-- : --	-- : --	-- : --	--
	6.0	10	100: --	-- : --	-- : --	-- : --	-- : --	--
	9.5	10	90: --	10 : --	-- : --	-- : --	-- : --	--
Untreated controls	--	10	20: --	70 : 10	-- : --	-- : --	-- : --	--

¹Reported to contain urea, dicyandiamide, formaldehyde, and phosphoric acid.

Table 54.--Summary of 2- by 4-inch stake test results obtained in Mississippi with wood preservatives in general use

Preservative	Average retention	Data : Average : from : life : table : No. :	Remarks
	Pcf	Yr	
Acid copper chromate (Fed. Spec. TT-W-546)	: 0.26 ¹ / _(.013) : .30 (.14) : .51 (.25) : .52 (.26) : .60 (.29) : .75 (.37) : 1.01 (.50) : 1.54 (.76)	: 15 : 11.6 : : 46 : -- : : 47 : -- : : 15 : -- : : 46 : 4.6 : : 15 : -- : : 47 : -- : : 47 : -- :	: 90 pct failed after 10 yr : 40 pct failed after 9 yr : 20 pct failed after 31 yr : 30 pct failed after 31 yr : 20 pct failed after 9 yr : 20 pct failed after 9 yr
Ammoniacal copper arsenate (Fed. Spec. TT-W-549)	: .25 (.24) : .53 (.51), 1.00 (0.97), 1.29 (1.25)	: 14 : -- : : 14 : -- :	: 30 pct failed after 32 yr : No failures after 32 yr
Chromated copper arsenate Type I (Fed. Spec. TT-W-550) Type II (Fed. Spec. TT-W-550)	: .26 (.15) : .50 (.29), .78 (.44) : (.26), (.37), (.52) : (.79), (1.04)	: 15 : -- : : 15 : -- : : 20 : -- : : : : :	: 70 pct failed after 31 yr : No failures after 31 yr : No failures after 27 yr
Chromated zinc arsenate (former Fed. Spec. TT-W-538)	: .28 (.11) : .42 (.22) : .44 (.29) : .48 (.20), .97 (.40), 1.27 (.53) : .55 (.29) : .73 (.38) : .98 (.52) to 1.34 (.70)	: 24 : -- : : 4 : -- : : 4 : -- : : 24 : -- : : -- : -- : : -- : -- : : 4 : -- :	: 80 pct failed after 25 yr : 80 pct failed after 36-1/2 yr : 56 pct failed after 36-1/2 yr : No failures after 25 yr : 56 pct failed in 36-1/2 yr : 10 pct failed in 36-1/2 yr : No failures after 36-1/2 yr
Chromated zinc chloride (Fed. Spec. TT-W-551)	: .49 (.30) : .76 (.47) : .76 (.46) : 1.02 (.63) : 1.02 (.62) : 1.50 (.92) : 1.57 (.96) : 2.91 (1.78) : 6.0 (3.67)	: 2 : 14.2 : : 2 : 20.2 : : 47 : -- : : 2 : 20.1 : : 47 : -- : : 25 : -- : : 47 : -- : : 25 : -- : : 25 : -- :	: 30 pct failed after 9 yr : 30 pct failed after 9 yr : 60 pct failed after 25 yr : 10 pct failed after 9 yr : 20 pct failed after 25 yr : No failures after 25 yr
Copper naphthenate 0.11 pct copper in No. 2 fuel oil .29 pct copper in No. 2 fuel oil .57 pct copper in No. 2 fuel oil .86 pct copper in No. 2 fuel oil	: : 10.3 : 10.2 : 10.6 : 9.6	: : : : 7 : 15.9 : : 7 : 21.8 : : 7 : -- : : 7 : -- :	: : 80 pct failed after 35 yr : 60 pct failed after 35 yr
Creosote, coal-tar	: 4.1 : 4.2 : 4.6 : 8.0 : 8.3 : 10.0 : 11.8 : 14.5 : 16.5	: 17 : 14.2 : : 4 : 17.8 : : 5 : 21.3 : : 4 : -- : : 20 : -- : : 5 : -- : : 4 : -- : : 5 : -- : : 4 : -- :	: 40 pct failed after 36-1/2 yr : 10 pct failed after 27 yr : 60 pct failed after 36 yr : 20 pct failed after 36-1/2 yr : No failures after 36 yr : No failures after 36-1/2 yr
Low residue, straight run	: 8.0	: 18 : 17.8 :	
Medium residue, straight run	: 8.0	: 18 : 18.8 :	
High residue, straight run	: 7.8	: 18 : 20.3 :	
Medium residue Low in tar acids Low in naphthalene Low in tar acids and naphthalene	: : 8.1 : 8.2 : 8.0	: : : : 18 : 19.4 : : 18 : 21.3 : : 18 : 18.9 :	
Low residue, low in tar acids and naphthalene	: : 8.0	: : : : 18 : 19.2 :	
High residue, low in tar acids and naphthalene	: : 8.2	: : : : 18 : 20.0 :	

Table 54.--Summary of 2- by 4-inch stake test results obtained in Mississippi with wood preservatives in general use--continued

Preservative	Average retention	Data : Average : from : life : table : No. :	Remarks
	Pcf	Yr	
Creosote, coal-tar--continued			
English vertical retort	: 5.3 : 8.0 : 10.1 : 15.0	: 19 : -- : 60 pct failed after 28 yr : 18 : 18.9 : -- : 19 : -- : 30 pct failed after 28 yr : 19 : -- : No failures after 28 yr	
English coke oven	: 4.7 : 7.9 : 10.1 : 14.8	: 19 : 16.3 : -- : 18 : 13.6 : -- : 19 : -- : 70 pct failed after 28 yr : 19 : -- : 70 pct failed after 28 yr	
Fluor chrome arsenate phenol type A (Fed. Spec. TT-W-535)	: .2 (0.12) : .3 (.19) : .35 (.22) : .50 (.31) : .61 (.38) : .75 (.47)	: 2 : 10.2 : -- : 2 : 18.0 : -- : 37 : -- : 38 pct failed after 17 yr : 37 : -- : 50 pct failed after 17 yr : 2 : 24.1 : -- : 37 : -- : No failures after 17 yr	
Pentachlorophenol (various solvents) ²			
Liquefied petroleum gas	: .14 : .19 : .34 : .34 : .49 : .58 : .65	: 42 : -- : 20 pct failed after 15-1/2 yr : 42 : -- : 60 pct failed after 15-1/2 yr : 42 : -- : No failures after 15-1/2 yr : 45 : -- : 20 pct failed after 13 yr : 45 : -- : No failures after 13 yr : 42 : -- : No failures after 15-1/2 yr : 45 : -- : No failures after 13 yr	
Stoddard solvent (mineral spirits)	: .14 : .18 : .2 : .2 : .38 : .4 : .67	: 42 : -- : 90 pct failed after 15-1/2 yr : 42 : -- : 50 pct failed after 15-1/2 yr : 22 : 9.5 : -- : 17 : 13.7 : -- : 42 : -- : No failures after 15-1/2 yr : 22 : 15.5 : -- : 42 : -- : No failures after 15-1/2 yr	
Heavy gas oil (Mid-United States)	: .2 : .4 : .6	: 17 : -- : 33 pct failed after 28-1/2 yr : 17 : -- : 10 pct failed after 28-1/2 yr : 17 : -- : 10 pct failed after 28-1/2 yr	
No. 4 aromatic oil (West Coast)	: .2 : .4	: 22 : -- : 80 pct failed after 27 yr : 22 : -- : 20 pct failed after 27 yr	
AWPA-P9 (heavy petroleum)	: .11 : .19 : .29 : .53 : .67	: 42 : -- : No failures after 15-1/2 yr : 42 : -- : No failures after 15-1/2 yr : 42 : -- : No failures after 15-1/2 yr : 45 : -- : No failures after 13 yr : 42 : -- : No failures after 15-1/2 yr	
Untreated stakes	: --	: Misc. : 1.8 : -- : : to : : : 3.6 :	

¹Retention values in parentheses are based on preservative oxides.²See tables 5 and 17 for pentachlorophenol in other solvents.

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<p>U.S. Forest Products Laboratory.</p> <p>Comparison of wood preservatives in stake tests (1977 progress report), by Harley L. Davidson, Madison, Wis., FPL, 1977. 81 pp., tables (USDA For. Serv. Res. Note FPL-02).</p> <p>Compares wood preservatives used on test stakes of southern pine sapwood on five different sites.</p> <p>KEYWORDS: Wood preservatives, preservative retention, service life, outdoor exposure, stakes.</p>	<p>U.S. Forest Products Laboratory.</p> <p>Comparison of wood preservatives in stake tests (1977 progress report), by Harley L. Davidson, Madison, Wis., FPL, 1977. 81 pp., tables (USDA For. Serv. Res. Note FPL-02).</p> <p>Compares wood preservatives used on test stakes of southern pine sapwood on five different sites.</p> <p>KEYWORDS: Wood preservatives, preservative retention, service life, outdoor exposure, stakes.</p>
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